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A FREIGHT RATE OF 2.19 MILLS PER TON MILE is said to have been made by the Chesapeake & Ohio R. R. on coal delivered at Newport News, Va. The railway company has agreed to deliver the coal at tidewater for $1.70 per ton, and it costs 80 cts. per ton at the mines from which it is hauled, a distance of 410 miles. It is also stated that the Pennsylvania, Baltimore & Ohio and Norfolk & Western roads have made heavy reductions on bituminous coal hauled to tidewater.

THE MONTREAL, OTTAWA & GEORGIAN BAY Canal project was brought before the Canadian Premier on March 2. The canal promoters asked for a grant of $250,000 per year until the aggregate sum amounted to $6,000,000. The Premier said the scheme was no doubt a good one, but similar good schemes were applying to the Dominion for subsidies amounting to $50,000,000 in all. He promised, however, to examine into the project from the standpoint of national interest. The main argument advanced by the promotors of the canal was that such a canal would shorten the distance between Montreal and Chicago by 750 miles, and to Liverpool from Chicago by 1,400 miles. The estimated cost of a 14-ft. canal was $15,000,000; but the prospectus admits that an 18 to 20 ft. depth is really needed and the final cost will probably be $25,000,000.

THE NEW PANAMA CANAL CO., which is now said to be quietly but steadily working upon the construction of a lock-canal, was organized in Paris on Oct. 1, 1894, just in time to save the concession from Colombia, which expired on Oct. 31, 1894. Stockholders subscribed $4,000,000 towards the work and from some of the thieving promoters of the old company a further sum of $3,400,000 was forced. The report of the commission of Dutch, Belgian and French engineers, submitted in May, 1890, estimates that a lock-canal could be built for $180,000,000, including interest on the investment and 20% for contingencies. The estimated traffic was 1,000,000 tons for the first year, and 6,000,000 tons 12 years after the opening of the canal. The latter amount would yield $12,250,000 annually in net tolls, which would be about 25% higher than the tolls on the Suez Canal. The estimated value of work done and plant on hand was $90,000,000. The United States of Colombia has granted a further concession extending the time of completion to 1904. Under the present administration it is claimed that the strictest economy is being practiced and the latest devices for cheaply handling earth and rock are being introduced.

A SHIP-CANAL CONNECTION, between Lake Michigan and the Mississippi River, has been reported upon by Major W. L. Marshall, Engineer Corps, U. S. A., under the authority of a clause in the last river and harbor bill ordering such an examination. The general scheme is said to be feasible by utilizing the Chicago drainage canal, and four alternate plans are presented: (1) By canals past the 22 miles where high water velocities are decisive; (2) By building dams so high or short that the area of spillways shall be small in comparison with the cross-section of the pools; either of these plans mean wide, overflowed areas; (3) By much enlarging the natural waterway through pools by excavation; (4) By enlarging the existing canal, or building another along the whole line. The routes are about of equal lengths from navigable water in the Chicago River to the present head of navigation in the Illinois River, or 97 miles. The Illinois and Michigan Canal now connects the Chicago River, about 5 miles above its mouth, with La Salle. No estimates of cost are submitted; but Major Marshall advises an appropriation of $30,000 for making additional surveys and fixing upon general route and dimensions; or $75,000 if detailed plans, etc., are required.

CIVIL SERVICE EXAMINATIONS will be held as follows in New York: March 18, superintendent of maintenance and assistant superintendent of maintenance in the Department of Street Improvement; March 19, general inspector, Department of Street Improvement; March 22, architectural draftsman, Board of Education; March 23, building inspectors of iron and steel construction. Mr. S. William Briscoe is Secretary of the City Civil Service Commission, with office in the New Criminal Court Building.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of a work train on the Baltimore & Ohio R.R., near Zanesville, O., March 4. The train went down a 20-ft. embankment, and three men were killed, while 8 or 9 were more or less seriously injured.

THE COLLAPSE OF A VIADUCT occurred March 3 at Cincinnati, O. About 200 ft. of the west approach of the Eighth St. viaduct gave way, and fell into Mill Creek, having been undermined by the high water. Gas and water mains and electric wires were broken, causing considerable trouble.

A GAS EXPLOSION occurred under the street surface at the intersection of Tremont and Boylston Sts., Boston, Mass., March 4. The gas had leaked from two 6-in. mains which cross the new subway at this point, and had collected in the unfilled space between the roof of the subway and the temporary boarded surface of the street. It is supposed that a spark from the motor of an electric car caused the explosion. One car was thrown up into the air and two others were upset, while people were knocked down and windows shattered by the force of the shock. Six persons were killed and about 50 more or less injured. It is said that complaint had been made to the gas company about the smell arising from the leaking gas, and that it will be a subject for investigation whether the gas company or the subway contractors are responsible for the leak.

A FAST RUN was made March 2 by the special train carrying the new Vice-President, Mr. Hobart, and his party from Jersey City, N. J., to Washington, D. C., for the inauguration ceremonies on March 4. The route was over the Central R. R. of New Jersey, Philadelphia & Reading R. R., and Baltimore & Ohio R. R. The train was hauled as far as Philadelphia by engine No. 457, C. R. R. of N. J., weighing 226,000 lbs., and then to Washington by engine No. 1313, B. & O. R. R., weighing 223,000 lbs. The distribution of weight on the former engine was as follows: Driving wheels, 80,000 lbs.; truck, 34,300 lbs.; trailing wheels, 29,700 lbs.; tender, 82,000 lbs. The train weighed 372,770 lbs., and consisted of four cars, as follows: Baggage car (Blue Line), 66,320 lbs.; private car "Baltimore" (B. & O. R. R.), 95,200 lbs.; private car "Philadelphia" (P. & R. R. R.), 99,250 lbs.; private car "Atlas" (C. R. R. of N. J.), 112,000 lbs.; total 372,770 lbs. The record of the run was as follows:

	Time.	Distance, miles.	Mins. bet. stops.	Miles bet. st'ps
Jersey City .....left	11:15 a. m.	..	..	..
Elizabeth ..... "	11:28½ "	11.5	13½	11.5
Plainfield ..... "	11:40 "	23	11½	11.5
Bound Brook ..... "	11:46 "	30.2	6	7.2
Trenton Junction..arrived	12:15 p. m.	57.3	29	27.1
Trenton Junction .....left	12:17 "	57.3	..	..
Somerton ..... "	12:32½ "	71.9	15½	14.6
Jenkintown ..... "	12:39½ "	79.3	7	7.4
Wayne Junction ..... "	12:46 "	85.1	6¾	5.8
Phila. (24th St.) ..arrived	12:56 "	92.4	10	7.3
Phila. (24th St.) .....left	1:05 "	92.4	..	..
Wilmington ..... "	1:30 "	117.5	25	25.1
Baltimore ..... "	2:46 "	189.1	76	71.6
Washington .....arrived	3:23 "	228.6	37	39.5
Total distance, miles	....	228.6	..	228.6
Total time cons'm'd, mins	248	..	..	..
Time lost by stops, mins.	17	..	..	..
Actual runn'g time, mins.	231	..	..	..
Av. speed (exclusive of stops), miles per hour....				60

THE ELEVATION OF ITS TRACKS IN CHICAGO will probably be carried out by the Chicago, Burlington & Quincy R. R., as the Supreme Court has rendered a decision compelling the company to remove the fences which now block 15 to 20 streets which should cross the present tracks at grade.

THROUGH TRAFFIC over the Brooklyn Bridge by cars of the Brooklyn elevated and electric railways will not be decided upon until the question of compensation has been settled. At the meeting on March 8 the entire question, on motion of Mayor Strong, of New York, was referred to a committee to consider this question of compensation. In his report on the feasibility of the plan, Mr. C. C. Martin, M. Am. Soc. C. E., Chief Engineer of the bridge, states that while he thinks it practicable to run elevated railway trains on the bridge in connection with the bridge trains, and to run the trolley cars over the bridge on the roadways, he believes, however, that the proper and best solution of the whole problem is to allow the present bridge to continue its service and to construct a new bridge near the present one, which shall be for the accommodation of elevated and electric cars.

THE BOSTON TERMINAL STATION, described in our issue of Jan. 14, will have its basement below the tide level, necessitating careful provision for making the foundations waterproof. The waterproofing, of which 15 acres, more or less, will be used, is to be made by placing together several layers of felt and tar paper with a coal-tar composition binding them together. The thickness of the waterproofing will be less than 1 in., and it will be laid upon or embedded in concrete.

A 60-MILE ELECTRIC RAILWAY, to be operated by alternating current, is projected to connect the cities of Detroit and Port Huron, Mich. The line will be single track, with turnouts, following the western bank of the St. Clair and Detroit rivers and the shore of Lake St. Clair. It will carry both freight and passengers. Two-car trains will be run, consisting of a 33½-ton motor car and a 15-ton trail car. There is to be but one generating plant on the line, about 20 miles from Detroit at a point which will be about the centre of load distribution. Three-phase current will be generated at this station, which will be converted by rotary transformers placed at four substations along the line, from which direct current will be delivered into the feeder circuits. Mr. John D. Dyar, of Detroit, is to be the builder and Mr. Chas. G. Armstrong, of Chicago, is the consulting electrical engineer.

FIRE DESTROYED THE POWER HOUSE, except the walls, of the Union Traction Co., at 13th and Mt. Vernon Sts., Philadelphia, on March 4, ruining the engines and machinery, and causing a total loss estimated at $500,000. This power house was the central distributing point of the Philadelphia traction system, and contained boilers, engines and electric generators capable of furnishing 8,000 HP. The fire caused a general stoppage of street car service in the central portion of the city for several hours, until connections could be established with the circuits furnished by the eight other power houses of the company, which are located at various points throughout the city and suburbs. The cause of the fire is said to have been a short circuit between one of the dynamos and a heavy chain hanging from an overhead crane. This led to a discharge of sparks, with a crash as of a lightning explosion, which set fire to the oil-saturated wooden floor. The fire spread so rapidly over the floor and to the wooden roof that the attendants barely had time to escape with their lives. A new power house will probably be built on another location on the river front, where coal may be received more cheaply than at the old power house. It is to be hoped that one of the lessons of this fire, viz.: that the floor of a power house should not be made of wood, will be heeded in the construction of the new house.

AN ELECTRIC AND WATER POWER PROJECT now being put forward by the Denver Consolidated Electric Co., of Denver, Colo., is to establish a great reservoir for power purposes near Leadville, Colo., on what is known as the Sugar-Loaf site. The dam will be 40 ft. high, and the head of water from the intake of the flume to the Pelton wheels in the power house will be 345 ft.

THE BALTIMORE ELECTRICAL SUBWAY PROJECT is in a tangle, and ordinances lately passed by the city council may be tested in the courts. Mr. N. S. Hill, Jr., Chief Engineer of the Water Department and Subway Commission, pointed out that under the ordinances, as lately amended, the Edison Company is only required to lay its wires in such city conduits as are trunk lines, and is permitted to lay its own tubes on side streets. This interpretation would affect nearly 60% of the total mileage of the proposed city conduits, and to that extent destroy the purpose of municipal ownership and absolute control of the subways. According to the city press of Baltimore, politics is chiefly responsible for all the present trouble and delay.

THE SAND-BLAST APPARATUS described in our issue of March 4, p. 139, was again experimented with on March 2, in removing the paint from the hull of the U. S. cruiser "Atlanta," with the result of doing the work with much greater rapidity than on the first trial, and it will now be used to clean the whole of the hull. A similar experiment was made two days later on the columns of the viaduct at 155th St., New York city, which were erected in 1890 and which now need re-painting. A number of well-known members of the American Society of Civil Engineers were present, including Messrs. E. P. North, Water Purveyor of New York; Chas. Macdonald, L. L. Buck and W. B. Parsons. The removal of the paint and scale, exposing the clean iron surface, was most thorough, the rate of removal being about 1 sq. ft. in two minutes.

TWO NEW INTERLOCKING PLANTS.

A considerable amount of the business now undertaken by the manufacturers of signal and interlocking plants is for the protection of busy and complicated railway junctions, and we illustrate this week two plants of this kind which have recently been installed by the National Switch & Signal Co., of Easton, Pa.

Philadelphia & Reading R. R.

The Philadelphia & Reading R. R. has recently put in a new system of tracks at the Germantown Junction (17th St., Philadelphia, Pa.) in order to complete its four-track system at this point, and to enable it to run at very high speed from the express tracks onto the main line or

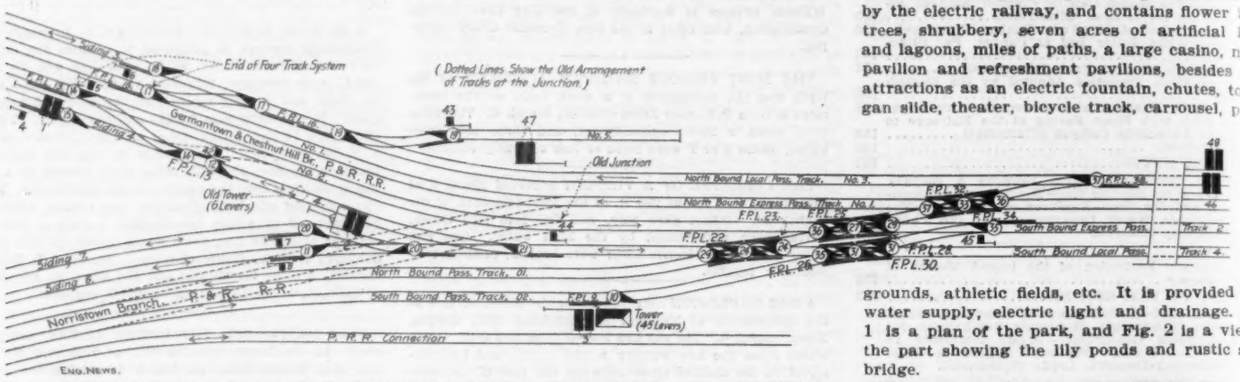

End of Four Track System
(Dotted Lines Show the Old Arrangement of Tracks at the Junction.)
Siding 3
Siding 2
Germantown & Chestnut Hill Br.
P. & R. R. R.
Old Tower (6 Levers)
Old Junction
No. 5
No. 1
No. 2
North Bound Local Pass. Track, No. 3.
North Bound Express Pass. Track, No. 1.
South Bound Express Pass. Track 2
South Bound Local Pass. Track 4.
Siding 7
Siding 8
Norristown Branch
North Bound Pass. Track, 01.
South Bound Pass. Track, 08.
Tower (45 Levers)
P. R. R. Connection
ENG. NEWS.

FIG. 1.—PLAN OF INTERLOCKING PLANT AT GERMANTOWN JUNCTION (PHILADELPHIA); PHILADELPHIA & READING R. R.
National Switch & Signal Co., Contractors.

branch tracks as required. The arrangement of the tracks is shown in Fig. 1, the dotted lines in which show the former arrangement at the junction. The new junction with the Norristown Branch is made about 800 ft. south of the old junction by means of slip crossings, and then, after following along parallel with the Germantown Branch for several hundred feet, connection is made with the original location by a 2° curve. The double track of the Norristown branch now connects with the four-track line of the Germantown branch by a series of four double slip switches with movable point frogs. The slips are 112 ft. long, with No. 15 frogs and 28 ft. switch rails, so that trains can pass safely and easily without reducing speed. The plant is particularly interesting for this feature, and it is said these are in all probability the longest double-slip switches ever made, and the longest ever operated through an interlocking plant.

The interlocking of the junction is controlled by a National machine having 45 working levers and three spare spaces; 18 levers are for the operation of 32 switches, 4 moveable point frogs and 9 switch and lock movements; 12 levers are for 31 facing point locks and detector bars, and 15 levers are for 21 signals. The slip switches are locked by two levers each, this being necessary on account of the length of detector bars required for them. The tower is of the company's latest design. The exterior is covered with metal and is very plain in design. The window sills of the second floor are only 18 ins. above the floor, thus giving the lever man a very much better view of the track than is possible with the ordinary form of window. The window sashes slide horizontally instead of vertically and the top of the window is only 6 ft. 6 ins. above the floor. Attention is called to this point, for the reason that it has been the practice in the past to have a great amount of unnecessary window surface above the line of vision, necessitating awnings or window shades.

The work of installing this plant had to be carried out with very great care, on account of the amount of traffic at this point. Mr. Frank D. Hain, Assistant Supervisor of the Philadelphia & New York Division, P. & R. R. R., to whom we are indebted for much of the information respecting this plant, states that over the Norristown branch trains run to Norristown and points as far north as Williamsport, amounting to 45 trains each way per day. Over the Germantown branch run all trains to New York, Buffalo and the West, and several Philadelphia suburban points, amounting to 135 trains each way per day. In addition to this there are shifting movements amounting to about 30 each way per day.

The interlocking switch and signal plant is operated in conjunction with the Hall system of automatic block signals. The track work was done by the railway company's men, under the direction of Mr. E. C. Tomlinson, Division Superintendent.

Great Northern Ry.

A complicated junction at Seattle, Wash., which has recently been equipped with interlocking plant is shown in Fig. 2, and a general view of the situation is given in Fig. 3. It will be noted that it has an unusual feature of complication in having to provide for mixed gage tracks. The plant was put in for the Great Northern Ry., but the tracks include those of the Great Northern Ry. and Northern Pacific R. R. (both standard gage, 4 ft. 8½ ins.), and the Columbia & Puget Sound Ry. (3 ft. gage). The whole plant is in a very busy section of the city, being located near the wharves. The tracks are carried on piling and the whole trestle structure is covered with heavy planking in order to permit teams to pass over the

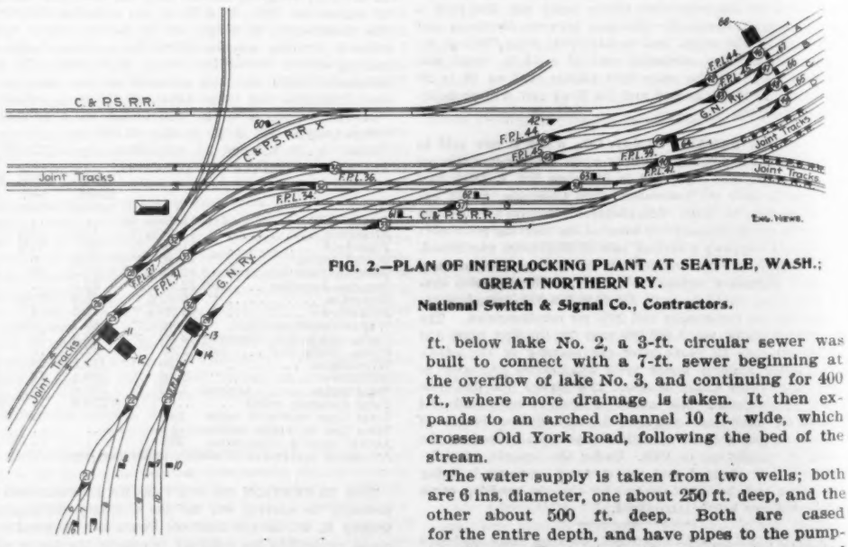


FIG. 2.—PLAN OF INTERLOCKING PLANT AT SEATTLE, WASH.; GREAT NORTHERN RY.
National Switch & Signal Co., Contractors.

tracks. This planking being flush with the top of the rails, prevented the installation in the usual manner and made it necessary to put in the switch and lock movements, bell cranks, pipes, wires, etc., below the ties. This is shown in Fig. 4, which also shows part of the mixed gage tracks, with stub switches. The interlocking machine has 47 working levers and 21 spare spaces for future extensions. There are 19 levers for the operation of 25 switches, 13 switch and lock movements and one signal; 10 levers for 12 facing point locks, and 18 levers for 22 signals. Over three miles of 1-in. pipe and nearly five miles of wire were required. The work of installing the plant was done under the direction of Mr. J. D. Mason, Assistant Engineer, Great Northern Ry.

AMUSEMENT FEATURES AT WILLOW GROVE PARK, PHILADELPHIA.

(With two-page engraving.)

Willow Grove is 15 miles from Philadelphia, on the Old York Road Division of the Union Traction Co.'s electric railway. In 1896 the Union Traction Co. laid out a park or pleasure resort there to attract patronage. The park is encircled by the electric railway, and contains flower beds, trees, shrubbery, seven acres of artificial lakes and lagoons, miles of paths, a large casino, music pavilion and refreshment pavilions, besides such attractions as an electric fountain, chutes, toboggan slide, theater, bicycle track, carrousel, picnic grounds, athletic fields, etc. It is provided with water supply, electric light and drainage. Fig. 1 is a plan of the park, and Fig. 2 is a view of the part showing the lily ponds and rustic stone bridge.

The entire work was constructed for the Union Traction Co., by Messrs. Wendell & Smith, as managers. Mr. Chester E. Albright, C. E., of Philadelphia, Pa., was the engineer for the managers, and was assisted by Messrs. Elmer E. Shelly, E. J. Kerrick, and Charles F. Mebus. The latter had immediate charge of the construction and operation of the fountain and mechanical equipment of the park, and we are indebted to him for information, photographs, blueprints, etc., made use of in this article.

Since almost half the park is low ground over which used to flow the surface drainage of more than a square mile of country the first engineering problem was to provide for carrying off the storm water. The lakes or lagoons form a part of the general drainage scheme. From a point 600 ft. below lake No. 2, a 3-ft. circular sewer was built to connect with a 7-ft. sewer beginning at the overflow of lake No. 3, and continuing for 400 ft., where more drainage is taken. It then expands to an arched channel 10 ft. wide, which crosses Old York Road, following the bed of the stream.

The water supply is taken from two wells; both are 6 ins. diameter, one about 250 ft. deep, and the other about 500 ft. deep. Both are cased for the entire depth, and have pipes to the pumping house. From here the water is pumped against a head of 110 ft. into a 4-in. main running the entire length of the park, and extending beyond to an iron stand-pipe on high ground; the stand-pipe is 20 ft. diameter, and 35 ft. high. From the 4-in. main branches are run to all the buildings and to various drinking fountains and hydrants around the grounds. The consumption averages 100,000 gallons per 24 hours. It was found that one well alone would furnish an

ample supply and never showed any signs of weakening.

The power house is outside the park and contains eight return tubular boilers with a total capacity of 950 HP. From this house a 6-in. steam main is run to the casino, and from the casino a 3-in. pipe is run to the pump-house and small pavilion in the picnic ground. This supplies steam under a pressure of 85 lbs. to the casino for all cooking and heating, and for running the ammonia compressor in the cold storage plant. The power house also contains the generators which furnish current for part of the electric railway on Old York Road, and for all lighting and motors in the park. All cables and wires are carried from the power house in wooden conduits to the various buildings and light poles, there being no overhead wiring except for the electric railway.

FIG. 3.—VIEW OF INTERLOCKED JUNCTION AT SEATTLE, WASH.

The park is lighted by 90 arc lamps and 120 incandescent lamps around the lakes; the buildings are also studded with incandescent lamps around the eaves and other main outlines. The arc lamps are of the Helios make, taking 12 amperes and 45 volts, connected in series of ten on the 500-volt circuit; 45 of the lamps are hung on ornamental iron poles 40 ft. high, with five lamps on each pole. In addition to the 90 arc lights mentioned, the bicycle track is lighted with 20 arc lights for night meetings. The lights around lakes No. 1 and No. 3 are Heisler incandescent lamps, of 5 amperes 25 volts, in series of 20 on the 500-volt circuit. They are placed in large glass globes on top of ornamental iron poles 8 ft. high, two lamps to each pole. All the lighting is on the 500-volt circuit, direct current, with the exception of the casino, music stand, women's pavilion and theater, which are lighted by 110-volt, 16-c. p. incandescent lamps on the three-wire system. Of these there are over 1,000. All conveyors, elevators, pumps, etc., in the park are driven by electric motors, of which there are eight, having an aggregate rated capacity of 185 HP., and all run on 500-volt circuits, direct current. One 20-HP. 4-pole General Electric Co.'s shunt-wound motor runs an 8½×8-in. single-acting Deming triplex power pump for elevator service at the chutes, and another runs an endless chain for conveying the boats from the lake to the loading platform of the chutes. A third runs an endless chain conveying cars up the incline to the toboggan slide. A 5-HP. 4-pole General Electric shunt-wound motor runs the rotating machinery for the carrousel, and another runs a 5×8-in. single-acting Deane triplex power pump to supply water for the park. A 5-HP. Lundell shunt-wound motor runs the freight elevator in the casino, and two series-wound General Electric motors run a 9×12-in. double-acting Gould's triplex power pump for the electric fountain.

The pump-house is an ornamental pavilion, 29 ft. in diameter and the pump-room floor is 7 ft. below the level of the lake, as shown in Fig. 3. Its inside diameter is 25 ft., and the height from floor to ceiling is 13 ft. The walls are 2 ft. thick, of rubble masonry laid in cement mortar and puddled on the outside with clay. The ceiling or roof of the pump room is constructed of I-beams with brick arches between, and the whole is concreted and finished on top with cement. The pump-room floor is made of 6 ins. of concrete with cement finish on top. The pump foundations are of solid concrete, 3 ft. deep. Access to the pump-room is by a stairway at R, which leads to the elevated iron platform P and stairway Q. The platform, P, is practically on the same level as the floor of the operating room O, where the chief operator stands to operate the fountain. From the floor of the pump-room a tunnel leads to the fountain.

Electric Fountain.

The construction of the fountain is shown in Fig. 3, and a view of it from the lake (with the casino on the right) is given in Fig. 4. The intake for the suction pipe is 30 ins. square, and almost at the surface of the water in the lake, placed thus to avoid any possibility of taking in stone or gravel and protected by double wire screens of fine mesh. The suction pipe, as shown in the plan, is below the floor of the pump room, and water is admitted to the Gould pump by an angle valve at Z. The Deane pump can also draw water from the lake through the same suction. From the Gould pump water is discharged into either manifold No. 1 or No. 2. Each manifold is 12 ins. diameter and has ten flanged tees 6 ins. diameter, and two flanged tees 3 ins. diameter. The corresponding tees of each manifold are connected by a tee fitting which leads to pipes in the fountain. Between the tee fittings and the tees on each manifold are set quick opening gate valves and check valves. The valve stems are connected with levers set in an iron frame on the floor above. By opening the valves in different combinations and by regulating the flow of water through them, the number and character of the displays may be varied very considerably. Each lever may be set in 14 positions, thereby changing the size of opening in each valve as many times. Another way of varying the displays is by running the motors in series or in parallel, thereby increasing or diminishing the discharge. Again, on each display at night can be thrown five different colors or the whole display can be shown in any one of these colors.

The method of pumping water is on a novel idea devised by Mr. Albright and it has worked very successfully. The pump is a 9×12-in. Gould's double-acting triplex pump, with a capacity of 50,000 gallons at 40 revolutions. It is driven by two General Electric railway motors, controlled by a General Electric series parallel controller, shown at H in plan. To the left of this is shown the plan of the frame in which the levers are set. The operator here has full control of the valves, switches and motors. Only one set of valves and one frame for levers are shown, but each is in duplicate. In case of accident the operator can quickly change from one to the other by controlling the flow of water in either manifold with large valves at the stairway Q.

The fountain proper is built in the bed of the large lagoon, about 100 ft. from shore. In plan it is square, with rounded corners. The inside floor is 6½ ft. below the surface of the water in the lagoon. The outside walls are built the same as the walls of the pump-house and tunnel. The fountain consists of two basins. The floors of the lower and upper basins are respectively 1½ ft. and 7 ft. above the level of water outside. Each floor is constructed of 5-in. I-beams, 3 ft. 6 ins. apart, and covered with ¼-in. plates upon which is laid 4 ins. of concrete, finished on top with cement. The outside wall of the lower basin is of stone plastered with cement. The inside wall from the lower to the upper basins (see A, on quarter plan of pipes) is of brick and plastered with cement. The outside wall of the upper basin, shown in half section at B, is made of "expanded metal" fastened on iron forms and then finished with cement. The large molding at C is made in the same way. The entire exterior of the fountain is thus of cement, which has a greyish tint. The effect is very pleasing, and is in keeping with the colonial architecture of the buildings in the park. All the ironwork in the basins is painted in the same tint. In the lower basin are five 6-in. feed pipes (only four are shown) for displays. No. 1 is circular in plan, and in it are set 100 nozzles, ¼-in. diameter, all pointing to the center with a small vertical angle. The display made by these nozzles is a cone under high pressure, No. 2 feeds eight nozzles, ⅝-in. diameter. The nozzles are placed directly over funnels shown at D, and make an angle of 8° with the vertical, all pointing toward the center of the fountain. No. 3 feeds eight rings which are placed about 18 ins. above the eight funnels in the lower basin. In each ring are set 68 nozzles, ⅛-in. diameter, at a small angle with the vertical and pointing midway between the center and circumference of the ring, which makes a display similar in appearance to a wheat sheaf and is known by this name. No. 4 feeds eight ¾-in. nozzles which project upwards through the vases at C. The nozzles are set vertical and are used largely for displays under low pressures. No. 5 is another circular pipe with 58 nozzles, ¼-in. diameter, set vertically, giving a cylindrical effect under pressures of 80 lbs. and over. No. 6 feeds six nozzles, ¾-in. diameter. Nos. 8 and 7 are similar, respectively, to Nos. 2 and 3 in the lower basin, differing only in the fact that all are set vertical. No. 7 feeds six ⅝-in. nozzles and No. 8 feeds 96 nozzles, 3-16-in. diameter. Nos. 6 and 7 combined form a prism of large jets. No. 9 feeds 88 nozzles, ¼-in. diameter, in two parallel pipes curved in a vertical plane, giving a display something like a Japanese fan, which is very effective. Nos. 10 and 11, not

Fig. 4.—View of Lead-Outs of Interlocking Plant at Seattle, Wash. (Showing Mixed Gage Tracks and Connections to Operating Rods Under the Ties.)

shown, supply, respectively, a small ring and a center nozzle, 1-in. in diameter.

All displays are, of course, made to the best advantage at night when illuminated with colored lights. For this purpose there are 15 cast iron funnels, seven in the upper and eight in the lower basins. These funnels are covered with ½-in. plate-glass, set in cement to make water-tight joints. Beneath each funnel, under the fountain, is a vertical focusing arc lamp of 8,000 c. p. Immediately under each funnel at F, and above the arcs, is a disk fastened on a vertical shaft free to move in a horizontal plane. Each disk has five circular openings in which are set lenses of different colors. At H, mounted on a horizontal shaft set in a frame, are 15 hand wheels, one of which is connected to a color disk by a link-belt chain to a small sprocket wheel under the disks. The assistant operator at H moves at will any one of the disks or the whole series under either upper or lower basins, thus throwing all five colors on streams or one color. The annunciator at K, operated from O, shows him what displays are

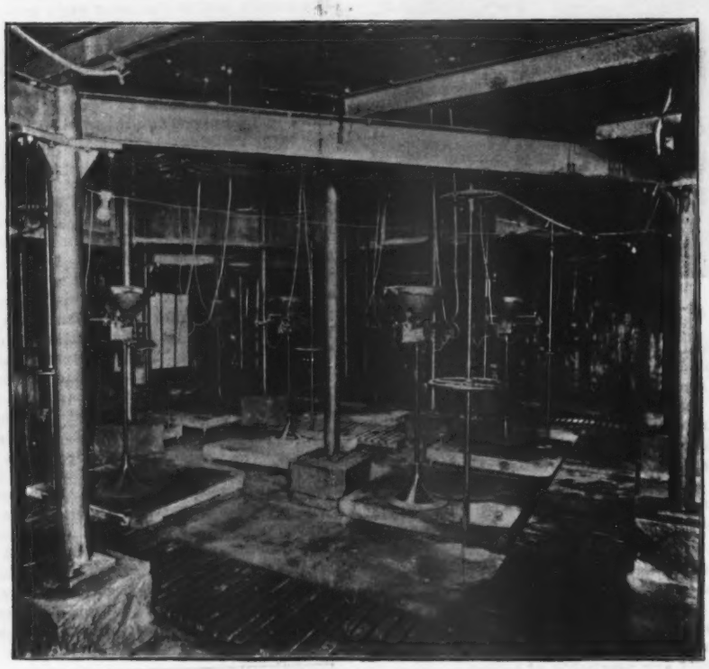


FIG. 5.—VIEW IN ELECTRIC LIGHT CHAMBER OF ELECTRIC FOUNTAIN AT WILLOW GROVE PARK, PHILADELPHIA, PA.

being made by the chief operator. Fig. 5 is a view in the operating room under the basins. The displays are made for about 15 minutes at a time. The fountain was constructed with some modifications after designs of F. W. Darlington, electrical engineer.

The Chute.

The chute, Fig. 6, consists of an inclined plane with a small body of water at its foot. Boats seating eight persons and a "captain" are lifted to the top of the plane where they are left to gravity and the care of the "captain." The momentum acquired in descending the plane drives the boat over the surface of the water for a distance of about 200 ft. The length of run is about 200 ft., and the grade is 1 in 4, or 25%. In Fig. 7, the boats are loaded at the platform at A, then taken to the turntable at B where they are turned and sent into the elevator C. After the descent down the incline D to the lake E, the boat is returned along the level track E to the starting point.

The artificial lake is approximately 250 ft. square and about 5 ft. deep. To prevent stirring up mud the bottom of the lake is planked with 1½-in. hemlock plank laid on stringers which are framed to posts planted in the bottom of the lake, the posts being surrounded by concrete for about 8 ins. on each side. The inclined plane is supported by iron columns, as shown. The runway is made of yellow pine stringers, 4×6 ins., bolted on the floor, and on top of these are fastened maple stringers, 2×2 ins., which serve as guides. The guides are greased every day during operation with a compound made of Albany grease and graphite. Where the plane strikes the water the guides are curved as shown, giving the boat a direction almost parallel to the surface.

The hydraulic elevators are operated under a pressure of 125 lbs., the cylinders and car make one round trip a minute. The pressure is supplied by a single-acting triplex power pump which is run by a 20-HP. shunt-wound electric motor. The pump runs continuously at a speed of 40 revolutions per minute, and pumps into a pressure tank of 1,500 gallons capacity, which supplies the cylinders of the elevators. The pressure is controlled by an automatic regulator and by-pass, so arranged that when the pressure reaches 125 lbs. the regulator opens the by-pass and the water merely circulates through the valve chambers. When the pressure falls below 125 lbs. the regulator closes the valve in the by-pass, and the pump discharges immediately into the pressure tank. The pump draws water from a supply tank into which the cylinders discharge.

The boats travel on four small wheels or castors 5 ins. in diameter. On each elevator carriage is a track which connects with the tracks from the turntable and the incline. The track on the elevator carriage is secured by hinges to two uprights on the end toward the turntable. When the empty carriage descends to the level of the turntable, the end of the track toward the incline which is free to move in a vertical plane strikes two posts planted in the pit of the elevator shaft. These support the track when down and keep it on the same level as the platform. As the carriage ascends, the forward end of the track leaves the supports and rests on the iron frame of the carriage—giving the track an inclined position of the same pitch as the inclined plane of the chute. At the rear end of the track a spring board, running the entire length of the carriage, is fastened and upon the center of this a lug is bolted. This catches a lug on the under side of the boat and keeps it in position while ascending in the elevator shaft. The operator on top, at G, after seeing that everything is all right, bears down on the spring board with his foot, thereby releasing the boat and sending it down the incline. When the boat stops on the lake, the "captain" sculls it to the shore, where a man catches it with a boat hook and pulls it in to the channel which leads to the track where the boat is caught at the bottom on the rear by an endless chain and taken to the platform from which it started. The endless chain is of the link-belt type, and is propelled by a 20-HP. shunt-wound motor. The round trip is made in about two minutes, and the fare is 5 cts. This chute is known as the Morris chute, named after the designer, Mr. E. Joy Morris.

Toboggan Slide.

The toboggan slide is a gravity railway, the profile of which, instead of being in a straight line, is made up of alternate short level lines and vertical curves of small radii, known as "dips," as shown in Fig. 8. The elevation does not exactly correspond with the profiles, owing to some changes made during construction, but it shows the method of construction. The profiles show the actual grades. The car after being loaded at C, is pushed by the attendant to A, the foot of the incline. Here an endless chain, similar to that used at the chute, catches the car and takes it to the top of the slide, F. From here the car is brought back to the starting point by force of gravity. The car runs in a trough, as shown by the cross-section at D and E, and has wheels on the side as well as on the bottom. In this way the frictional resistance in going around curves is reduced to a minimum and derailment is made impossible. The car is stopped before quite reaching the starting point by an attendant who operates two levers which bring two boards fastened to the track up against the under side of the car serving as brakes. Each car seats four persons. The endless chain is propelled by a 20-HP. shunt-wound electric motor at the foot of the slide at F. At Willow Grove the track takes the form shown in plan. Part is in woods and part in the open. The highest point is 50 ft. above the ground, rising almost to the tree tops. The entire length is about half a mile. This is said to be the first toboggan slide laid out on this plan and it has proved very popular. In places where space is limited the plan of the track is built oval in shape and made about three stories high, the tracks running under one another. This save considerable lumber and reduces the cost of construction. Such slides have generally not more than 1,000 ft. for the entire length of ride. The cross section shows two tracks on the same bent as from C to H, on the plan where the return track is directly under the outgoing track. The bents are 10 ft. apart.

A REPORT ON A GRADE CROSSING COLLISION BETWEEN A RAILWAY TRAIN AND AN ELECTRIC CAR.

The special dangers of grade crossings of steam railways by electric railways have been frequently pointed out in our columns, and we give below an instructive report on an accident of this kind which is taken from an advance copy of the report on Street Railways issued by the Board of Railroad Commissioners of Massachusetts, for the year ending Sept. 30, 1896:

Since the electric car began to take the place of the horse car, attention has been called from time to time to the greater risk of casualty at grade crossings of electric and steam railways. We have felt more strongly the difficulties as well as the responsibilities of dealing with this matter since the passage of the Act of 1895, which requires the consent either of this Board or of a special commission to the creation of new crossings of this kind. So far, all of the applications for such consent have been made to this Board. We regard it as our duty to carry out the policy intended by the Legislature, and it is largely in this view that we again call attention to the subject.

On Dec. 16, 1896, a New York, New Haven & Hartford R. R. passenger train collided with an electric car of the Dighton, Somerset & Swansea street railway at the Broad Cove crossing, so called, in the town of Somerset. The electric car was demolished and the train derailed. Fortunately no person was fatally injured, so that we were not required to investigate the causes of the accident. The case appeared, however, to present in such a new and somewhat startling aspect the perils of these crossings, more especially as involving the safety of railway travel, that we felt it our duty to make a special investigation, not so much to fix the responsibility or blame, if any, as to find out the lesson which the disaster might teach.

The accident happened about 8.30 a. m. There was at the time a thick, driving snowstorm, with a strong northeast wind. The colliding train consisted of engine and tender, combination car and two coaches. The train usually ran from Fall River to Taunton without stopping. This morning it was delayed after leaving Fall River by signal stops and by a late way train ahead of it, so that is was about 17 or 18 minutes behind time, and was proceeding at the rate of only 15 to 20 miles an hour as it approached the Broad Cove crossing. It was running on the east or northbound track, in the face of the wind and storm. The engineman had blown the whistle for the crossing, and the fireman was ringing the bell. The front window of the cab was clouded with snow, so that the engineer could not see through it, and he was looking ahead out of the east or right-hand window. He did not and could not see the electric car, which was crossing from the opposite or west side of the railway, until it shot into view directly in front of him, too late to stop or even check his train, though he took the usual means to do so.

The electric car had made the stop required by law at a distance of 10 to 15 ft. from the west or southbound main track. As the car came to a stop, the conductor got off the rear platform on the south or right-hand side of the car, that is, on the side towards the approaching train, went forward half running to the middle of the west or southbound track, looked quickly up and down the railway, did not see or hear the train, and beckoned the motorman to come on. The conductor then stepped back a few feet, and got on the rear platform of the car, on the same side, as it passed him. He had hardly got on, however, before he saw the train approaching close at hand, and jumped to the ground, but gave no warning to the motorman.

The flagman stationed at the crossing had in the meantime been standing in or near the door of his cabin, looking down the railway and watching for the train. His cabin is at the northwest angle of the crossing, so that the electric car passed between him and the train. The front end of the car had got a little more than half way across the tracks, when the flagman saw the train coming, and shouted to the motorman to hurry up. The motorman put on more power, and on receiving a second and more emphatic warning from the flagman, turned on the full power; but it was of no avail.

The locomotive struck the side of the electric car a little back of the middle, and literally tore it to pieces, carrying the fragments along with it or scattering them along the track. The locomotive and tender were derailed and capsized into the ditch. The combination car was also partially derailed and canted over. The two coaches remained on the track. The train moved just its length after striking the car. The derailment of the locomotive was probably caused by the trucks or motors of the electric car getting under its wheels, as portions of the former were found near where the locomotive was overturned. The demolished car was 33 or 34 ft. long, including platforms, and was said to weigh from 8 to 10 tons.

No one on the railway train was seriously hurt, probably owing in large measure to its low speed. There happened to be no passengers on the electric car. Two employees of the company, besides the motorman and conductor, were riding on the car before the accident. One of them was on the rear platform, and jumped off immediately after the conductor. The other was inside the car at the rear end. He was looking out of the window on the side towards the train, and seeing it coming had barely time to escape. The motorman was the only person on the car when it was struck. He afterwards found himself on the ground, on the slope of the railway embankment, with a rib crushed and otherwise severely battered, but he apparently received no permanent injury. How he came there, or how he escaped so easily, he cannot tell.

The Broad Cove crossing is not a blind or what is known as a "dangerous" crossing, but quite the reverse. It is a level crossing, and in clear weather an approaching train can be seen for a distance of half or three-quarters of a mile in either direction. The train was proceeding carefully and at reduced speed, and all the warnings and precautions required by law or rule appear to have been observed. The flagman might have cautioned the carmen with regard to the overdue train, but we do not think it was strictly his duty to do so. He did not know when the train would arrive, and had no right to flag the crossing or to hinder the passage of the car, until he had evidence that it was approaching. Electric carmen, moreover, appear ordinarily to pay no attention to a flagman or gateman, unless the flag is out or the gates closed. The conductor goes ahead and makes his own observation of the railway, and the motorman obeys his direction. The advice of the flagman is not as a rule sought, and if volunteered might probably be treated as superfluous if not meddlesome. In the present case, the car conductor, as is usual, made his own investigation of the safety of the crossing, and ordered the car to proceed. He had as good an opportunity to know if a train was approaching as the flagman; and perhaps the most mysterious circumstance connected with the accident is the fact that the conductor, who was a young man of 22, did not discover the approach of the train so soon as the flagman, who was nearly three times as old and farther away.

Nor can it be said that the law and rules were not obeyed in the handling of the electric car. The only statutory requirement, made years ago in the day of the horse car, is that the car be brought to a stop within 100 ft. of the crossing. This was done. There is no law, as is quite generally supposed, which requires the conductor to go ahead upon the railway, and the motorman to wait for his signal. This is only a rule of the railway companies; and, though intended as an additional safeguard, it may sometimes have the effect, in the case of a protected crossing, to shift or divide the responsibility as between the flagman or gate tender and the conductor of the car, and perhaps to make each less careful for the safety of the car. In the present case, at least, it added nothing to the security. The car was stopped as short a time as was possible under the rule. The conductor hurried forward, made a hasty observation, and beckoned the car ahead; and if he was negligent, he had, as the conductor from his position outside the car in such case always has, the first and best chance to escape the consequences.

The peculiar circumstance was the condition of the weather. The air was so thick with snow that the train could not be seen many hundred feet away, and the wind, blowing towards the train, drove the sound back so that the whistle and bell and noise of the train could not be, or appear not to have been, heard at the crossing. The conditions in this respect were, however, by no means exceptional. The same conditions prevailed that morning at most or all of the 218 other grade crossings of the same kind in this state,* many of them more blind and dangerous than this one. The same or similar conditions of obscurity from storm or fog or darkness occur not infrequently; and the chances of carelessness, neglect of precautions, derangement of appliances, and other miscarriage or mishap, are always present.

That under existing conditions some serious disaster will occur, is greatly to be feared, and is indeed as morally certain as any future event dependent on chances can be. If, in the present case, the electric car had been filled with passengers, or if the train had been running at express speed, the result would surely in the one case, and probably in the other, have been sufficiently tragic to arouse the public to a sense of the dangers involved and to the instant need of further provision for safety. If, moreover, a commission, specially charged with a care for the public safety in railway transportation, had expressly sanctioned the crossing on the ground, which is constantly urged, that it presented no unusual dangers, as this crossing does not, the commission would justly have been held to a full share of the responsibility for the disaster.

The facts of the collision at the Broad Cove crossing justify, we think, two inferences:

First.—The dangers at the grade crossings of electric railways with steam railways are in reality more than have been taken into account. It has been commonly assumed that the train, with its ponderous locomotive, would brush aside the electric car without seriously endangering its own passengers, as it usually does other highway vehicles; and it has sometimes been intimated that if the electric railway was willing to take the risk, the steam railway had little occasion to concern itself. The life of the passenger on the latter is of no more value than that of the passenger on the former; but it is clearly shown by the recent case that both are likely to be involved in the same catastrophe.

Second.—It is apparent that the risks at such crossings are too great, and the present provision for the security of life too small, as regards both the steam and electric railway. Several remedies may be suggested:

1. The plainest remedy is the separation of the grades of the railway and highway. There is now sufficient provision of law for doing this, except that the railway company has no power to initiate proceedings. Such power may properly be given, the railway company bearing a fair proportion of the cost.

2. Where the abolition of the highway grade crossing is for any reason impracticable, the route of the electric railway may often be deflected so as to pass over or under the steam railway, outside the limits of the highway. The objection is frequently encountered that the railway company can acquire land for this purpose only by purchase, and if at all, only at the owner's price. The right to take land in such case, under regulations and limitations similar, perhaps, to those which now apply in case of land required for improving the alinement of a steam railway, might well be given to the electric railway company. Such legislation seems to us highly desirable. This remedy would not infrequently remove the prime necessity for abolishing the highway grade crossing.

3. Some audible signal operated by the train, such that it begins to ring when the train is 1,500 or 2,000 ft. away, and continues to ring until the train has passed the crossing, might in many cases afford protection to the crossing. It is assumed that in the present stage of electrical development some automatic signal of this kind may be found which can be depended on to work reliably.

4. The more effectual and sure method of protecting the crossing would be by an interlocking apparatus, similar in principle to that in use at grade crossings of steam railways with each other. As applied to the crossing of a steam railway with an electric railway, the former should doubtless have as a rule the right of way, with derails, if any, only on the latter. This system of protection is required in the state of Ohio as regards all new crossings, and may be prescribed as regards all crossings; and we are informed that the law of Illinois is similar. One section of the Ohio statute, which was passed April 27, 1896, provides that

> In case one railway company, or an electric railway company shall hereafter seek to cross at grade with its track or tracks the track or tracks of another railway, the railway company, or the electric railway company, seeking to cross at grade shall be compelled to interlock such crossing to the satisfaction of the said commissioner (of railways and telegraphs), and to pay all costs of such appliances, together with the expense of putting them in and the future maintenance and operation thereof; provided, this act shall not apply to crossings of side tracks only.

Another section provides that engines, trains or electric cars shall not be required to stop at a crossing so protected.

*By the returns of the companies, there are 219 grade crossings of electric railways with steam railways in Massachusetts, at which 439 steam railway tracks are crossed by 276 electric railway tracks. The number of such crossings has nearly doubled in the last five years.

THE EFFICIENCY OF BUILT-UP WOODEN BEAMS.

By Edgar Kidwell.*

The timber resources of our country are decreasing so rapidly that already the engineer finds difficulty at times in obtaining beams of large size. This difficulty will steadily increase and force the constructor to resort more frequently to built-up beams such as have long been used in Europe. Though located in one of the leading lumber regions, the writer has at times been compelled to use such beams, and others have had the same experience.

But little information on this subject is to be found, and nearly every writer has contented himself with copying from Tredgold. Most authors warn the reader against the belief that a built beam is STRONGER than a solid one, thereby certainly strengthening the impression quite prevalent among builders, that it is as strong. The writer's experience lead him to a very different conclusion, hence he determined to make sufficient tests to furnish data upon which he could rely in his subsequent work. A full report of these tests will be published later, but since such reports are seldom within easy reach of the very men to whom these tests are of most value—the architect or engineer engaged mostly in country practice—it is deemed advisable to present here a brief summary of the results obtained.

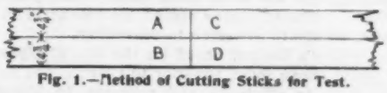
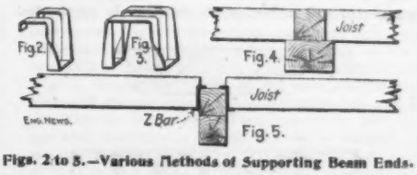


Fig. 1.—Method of Cutting Sticks for Test.

By "efficiency" is here meant the ratio of strength of a built beam to a solid one of the same size and quality of material. To determine the efficiency apart from the usual variations in the strength of different pieces of wood of the same size taken at random from the stock pile, the following method was employed:



Figs. 2 to 5.—Various Methods of Supporting Beam Ends.

Best quality clear white pine was used, and each piece was sawed into four sticks, as in Fig. 1. Of these, two pieces diagonally situated, say B and C, were made up into a compound beam, while A and D were tested singly as check pieces. The sum of the breaking loads of the two check pieces was doubled, and to this was added the weight of the two pieces. The result gives four times the average strength of a check piece, which is equivalent to the strength of a solid beam double the depth of the check piece, and of exactly the same quality. The breaking load of the built beam, corrected for weight, was then divided by

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the quantity just found, and the result was the efficiency of the built beam. Example in one case:

A. weighed 17 lbs.	broke at 2,700 lbs.
D. weighed 18 "	broke at 2,600 "
Sum..... 35	5,300

$2 \times 3{,}500 \div 35 = 10{,}635$, = probable strength of a full-sized beam.

Built beam weighed 42 lbs.	broke at 7,500 lbs.
Correct for weight	21 "
	7,521 "

$$\text{Hence, efficiency} = \frac{100 \times 7{,}521}{10{,}635} = 70.7\%.$$

Each beam tested had its own separate check pieces.

The relative stiffness of solid and built beams is a matter of paramount importance, yet no author

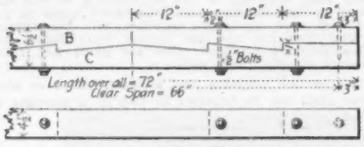

Fig. 6.—Indented Beam.

even mentions it. The writer, therefore, took special care to investigate this side of the subject, and the curves in Fig. 23 enable one to judge at a glance the relative stiffness. In computing the theoretical line of deflection the modulus of elasticity of white pine was taken as 1,000,000, which is about the average of tests made on solid pieces taken from the same stock.

Owing to lack of space but one set of tests is here reported, but the writer bases his conclusions on the results of all the built beams tested, which up to date are 74 in number.

Conclusions Drawn from the Tests.

It seems to be practically impossible to build a compound beam that will be as strong as a solid one. Indented beams are wasteful of material, costly to build and extremely inefficient and hence should be avoided. Clark's design (Fig. 7 shows the construction clearly) is not based on correct principles, and the beam lacks both efficiency and stiffness. The efficiency stated by Clark* is incorrect, owing to an error in reasoning.

The writer's design, based on the use of pipes, is a fairly cheap form, superior to Clark's, but inferior both in efficiency and stiffness, to keyed or joggled beams. The latter form appears to be in every respect superior to any other.

Blocking apart the component pieces of a keyed beam does not, contrary to the generally accepted view, increase the efficiency or the stiffness to any practical extent. The greater the number of pieces superimposed to form the compound beam the less the efficiency and stiffness, since in spite of any fastenings, the pieces act to some extent independently of each other, and each piece usually shows a well defined neutral axis.

The greatest defect in all built beams is the tendency of the keys or other fastenings to rotate in their slots, and unless such rotation is prevented,

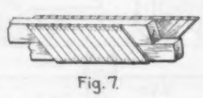

Fig. 7.

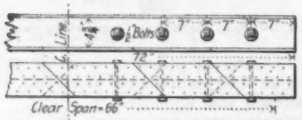

Fig. 8.

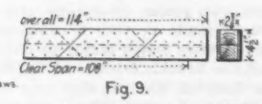

Fig. 9.

Figs. 7, 8, 9.—Various Forms of Clark Beams.

the component parts of the beam slip, and both the efficiency and stiffness are impaired. Numerous small keys closely spaced give better results than fewer large keys, since rotation can be more easily prevented and the beam is not weakened by large key slots. It is practically impossible to make an efficient beam by using bolts alone, since they easily bend, and the pieces slip. Spikes or drift bolts are even worse, as they draw out.

The resistance of soft wood to end pressure is so much greater than that of hard wood to side pressure, that hard wood keys even in beams of white pine or other soft wood, become indented and allow the component parts of the beam to slip. Oak keys certainly cannot, especially if the span is short, give satisfactory results in beams built of oak, the yellow pines or other hardwoods. Either a much harder wood must be got for keys, or else iron keys must be used if the construction is to be in reality what it often is only in appearance.

In the center of the beam a length equal to one quarter of the span should be left free of keys and bolts, except perhaps a few lag screws passing through the compression member, but not more than half way through the tension member.

The yielding of the wood around the bolts or pipes, against keys, etc.; the penetration of end wood into end wood in indented beams, and the slight rotation of keys in their slots, all conspire to produce in a built beam a set of conditions materially different from those existing in a solid one, the effect of which is to make the deflection greater than in a solid piece. Conditions existing

Fig. 10.

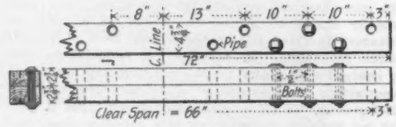

Fig. 11.

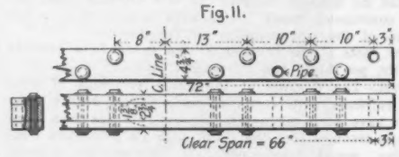

Fig. 12.

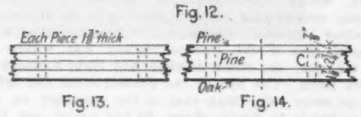

Fig. 13. Fig. 14.

Figs. 10 to 14.—Various Forms of Piped Beams.

in a solid beam are more nearly reproduced in a built one when a number of small, broad, iron keys are used, and are firmly driven up. Since these do not indent, the slip is less, hence the stiffness is greater, and by proper proportioning a built beam can by this means be made practically as stiff as a solid one, as evidenced by curves for beams Nos. 28 and 29.

The old builders advocated the use of oak or other hard wood on the tension side of a built beam. The writer finds from many tests that this plan produces practically no increase in the stiffness. The efficiency is raised somewhat, but not enough to compensate for the extra expense of using oak. It is cheaper and better to use a slightly larger pine beam.

If the designer bears in mind the preceding facts the writer thinks it will be perfectly safe to use in practice the following table. The data for Clark's beam, and beams using oak keys, apply only to beams made of white pine, or similar soft woods, but the other figures will apply equally well to any wood.

	Efficiency.	Relative deflection.
Solid Beam	1.00	1.00
Clark's Beam	0.70 to 0.75	2.00
Piped Beam	0.80 to 0.85	1.70
Keyed Beams.		
Oak Keys	0.90 to 0.95	1.25
Cast-iron Drive Keys	0.90 to 0.95	1.00
Flat Iron Keys*	0.75 to 0.80	1.50
Square Iron Keys	0.85 to 0.90	1.50

*Broadside vertical.

These efficiencies are based on a ratio of span to depth of beams equal to 12. With a greater ratio the efficiency may be slightly increased, but not enough, in the writer's opinion, to take into account.

It remains only to call attention to certain precautions which the writer knows are seldom observed. Built beams are often made as in Fig. 4, the joists resting on the lower piece. Sometimes they rest on a ledge-piece spiked to the lower half of the compound beam. There are objections to both methods. In nearly all the tests the tension side failed first; it is evident that when the pressure of the joists comes on the tension piece in the built beam this piece tends to act independently, like a continuous beam whose spans are the distances between bolts. If the bolts are in the slightest degree slack, the tension pieces drop away from the upper piece in compression, hence the tendency of the latter piece to act independently of the lower piece is increased, while the space made between the pieces greatly facilitates bending of the bolts and rotating of the keys. The weight of the floor ought to go on top of the beam, and if the joists cannot be made to bear directly on the built beam, they should be swung in stirrups (Figs. 2 and 3), or in some of the patent hangers.

The writer thinks that light Z-bars, as in Fig. 5, would give good results, but has not had an opportunity to try them.

Fig. 15.

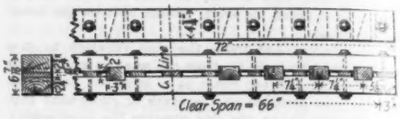

Fig. 16.

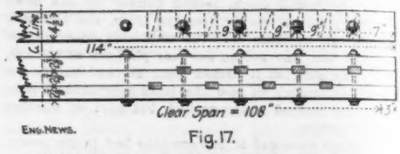

Fig. 17.

Figs. 15, 16, 17.—Beams Keyed with Oak.

Description of Beams.

Indented Beams.—Fig. 6 shows all particulars.

Clark's Beam.—Side struts were of ¼-in. white pine, secured by 2-in. wire nails, except No. 4, which had ½-in. Norway pine struts, and No. 5, which had 1-in. Norway struts secured by 3-in. nails. Bolts were used only in No. 6.

Piped Beam.—¾-in. steam pipe was driven into 1 1-16-in. holes. All bolts passed through the pipe.

Oak Keys.—White oak was used, grain of wood running lengthwise of keys. Keys were cut on taper of 1½-in. to the foot, and driven firmly home with a heavy mallet.

Cast-iron Keys.—These keys were ⅛ × 1 in., same taper as wooden ones, and driven up very tight with a light sledge.

Wrought-iron Keys.—These were tried in the endeavor to find a cheap substitute for the tapered cast-iron keys. They were merely pieces sawed from the bar, ground free of burrs at one end, then driven into slots which were sawed 1-16-in. narrower than the keys.

Table Showing the Results of Tests to Determine the Strength of Various Styles of Built-Up Beams, Compared with Solid Beams of the Same Dimensions

Kind of beam.	No. of test.	Fig. No.	Span, depth.	Efficiency, %.
Indented	0	6	10.2	69.5[1]
Clark's	1	8	12	70.7
"	2	8	12	67.3
"	3	8	12	72.2
"	4	8	12	77.6
"	5	8	12	72.8
"	6	8	12	67.9
Average				71.4
Clark's	7	9	24	65.0
"	8	9	24	80.0
"	9	9	24	97.6
Average				80.7
Piped	10	10	12	74.5
"	11	10	12	81.9
"	12	10	12	Flaw.
"	13	10	12	88.1
Average				81.5
Piped	14	11	12	88.4
"	15	11	15¼	86.9[2]
Average				87.7

*"Building Superintendence," T. M. Clark, 10th ed.; p. 92.

Piped	16	12	12	87.3
"	17	12	12	81.9
Average				84.6
Piped	18	13	12	55.5
"	19	14	12	97.2[2]
Oak keys	20	15	12	90.8
" "	21	15	12	82.6
" "	22	15	12	94.7
" "	23	15	12	Flaw.
" "	24	15	12	108.5
Average				94.1
Oak keys	25	16	12	92.8[4]
" "	26	16	12	82.6
Average				87.7
Oak keys	27	17	15.2	67.5
Cast-iron keys	28	18	12	88.9
" "	29	18	12	97.3
Average				93.1
Flat wrought-iron keys[3].	30	19	12	77.2
" " " .	31	19	12	72.3
" " " .	32	19	12	79.3
Average				76.3
Flat wrought-iron keys[3].	33	20	12	81.6
" " " .	34	20	12	78.0
" " " .	35	20	12	85.0
Average				81.5
Square wr't-iron keys..	36	21	15.2	87.5
" " " ..	37	22	22.7	87.8
" " " ..	38	22	22.7	91.1
Average				89.5

[1]Deflection of this beam was double that of a solid beam. [2]This beam was all white oak. [3]Tension side of white oak. [4]These two beams were blocked apart 15-16-in. in center, but are here figured at 5.5 deep, for comparison with the others. [5]Broad side vertical.

CAST COPPER OF HIGH ELECTRIC CONDUCTIVITY.

Cast copper has hitherto been considered so greatly inferior in electric conductivity to rolled copper as to be practically unavailable for use in construction of those parts of electrical apparatus in which high conductivity is essential. According to an article by Mr. Harold P. Brown in the "Electrical Review" of March 3, this objection to cast copper has been overcome by a new process of casting, the details of which are not published, the resulting product being known as "MB copper." It is said that Mr. Thomas A. Edison is interested in the development of the process and that the copper will be manufactured under his supervision at Menlo Park, N. J. Comparative tests made by Mr. Brown on samples of commercial "tempered" cast copper, MB cast copper

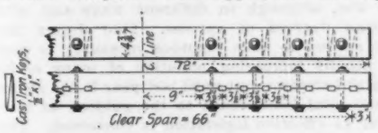

Fig. 18.

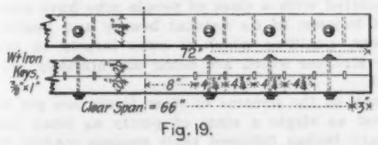

Fig. 19.

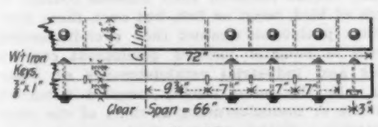

Fig. 20.

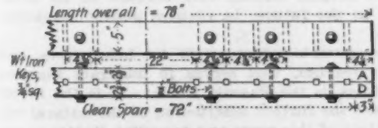

Fig. 21.

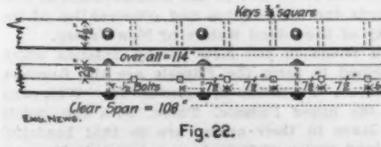

Fig. 22.

Figs. 18 to 22.—Beams Built with Iron Keys.

and rolled copper showed that the MB copper had a conductivity of from 92.3 to 97.5% of that of the rolled copper, while that of the "tempered" cast copper was only from 23 to 30%. The test bars were cylinders 25 ins. long and 0.8 in diameter, provided with enlarged terminals at each end, to which were amalgamated and coated with the Edison flexible solder. Analysis of the three bars showed the commercial cast copper to contain 99.15% of copper, the rolled bars 99.83% and the

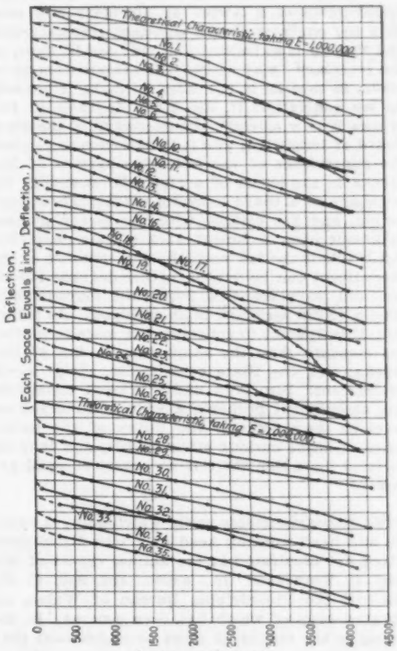

Fig. 23.—Curves Showing Relative Stiffness of Various Built-up Beams.

MB copper 99.85%. From tests of similar samples the tensile strength of the commercial cast copper was 19,000 lbs. per sq. in., while the MB was 30,000 lbs., or practically the same as rolled copper. In the tests currents of from 100 to 1,500 amperes were used, the latter being three times the proper current for the section of the bars. The electrical drop was measured in millivolts, and the rise in temperature also was recorded for each current. The following are the results:

Amperes.	Rolled Copper		MB Copper.			Commercial "Tempered" Cast Copper.		
	Deg. Fah.	Mil. V.	Deg. Fah.	Mil. V.	Per Ct.	Deg. Fah.	Mil. V.	Per Ct.
100	72	.003	72	.0032	94	72	.010	30
200	74	.0065	72	.007	93	74	.023	30
300	76	.0105	72	.011	95	78	.037	28
400	78	.0134	72	.014	96	79	.046	27
500	79	.017	72	.017	97	80	.060	26.6
600	80	.0195	72	.020	97.5	82	.071	27.4
700	81	.02225	72½	.023	96.7	86	.086	26.7
800	81½	.025	73	.027	94.4	92	.096	26.5
900	82	.028	73¼	.0295	95	96	.115	24.3
1,000	83	.03175	73½	.034	93.4	104	.130	23
1,100	83½	.035	74	.036	97	110	.145	24
1,200	84	.039	76	.040	97.5	118	.155	25
1,300	86	.042	78	.044	95	126	.165	25.4
1,400	88	.046	80	.048	96	138	.1825	25.2
1,500	90	.048	81	.052	92.3	150	.195	24.6
1,500	138	.053	136	.057	93	354	.220	24

The column of percentages gives the relative conductivity as compared with the particular sample of rolled copper tested, and not with the Matthiessen standard, the actual conductivity of this sample being higher than 100% of the standard.

It appears probable that the high results obtained by Mr. Brown from the MB copper were simply due to the fact that it was a very pure sample of cast copper, and that the same results may be obtained from MB or any other kind of cast copper which is of the same high degree of purity. Cast copper, as ordinarily made, is not pure, not for the reason that the ingot copper put into the crucible is not pure, but because while melting or after being melted it absorbs oxygen, the analysis of the final casting showing the presence of copper oxide. If pure Lake Superior copper were taken, such as is used for making fine electric wires, melted in a non-oxidizing atmosphere and cast in such a manner as to avoid oxygen entering the metal it is probable that as high conductivities as those found by Mr. Brown may be obtained. Mr. Brown gives the tensile strength of the commercial cast copper at 19,000 lbs. and that of the MB at 30,000 lbs. Tests of cast copper made by the U. S. Test Board in 1875 gave results ranging from 12,760 to 27,800 lbs. per sq. in., the lower result being due to oxidation, while Kirkaldy reports four tests of cast copper averaging 24,780 lbs. per sq. in. It appears that the tensile strength of cast copper is a measure of its purity, and that purity, tensile strength and electric conductivity increase together.

THE DUTY OF THE ENGINEER TOWARD HIS PROFESSION *

We wield and apply more of the capital of this country than all the other professions combined; yet, thus far, each engineer has practically been working singly and alone. But we are beginning to perceive that "in union there is strength." By the organization of bodies like this over which you are now called to preside, by affiliation with the larger national associations with which many of us are united, we are learning that the practicing engineer owes a duty to the co-laborers in his chosen vocation. This duty can only be performed by affiliation with, and active participation in, the affairs of the associations formed by and with his fellow workers.

In an especial manner does the working engineer owe allegiance to his local organization. Here we are known. Here we know each other. Here, if we act unitedly we can make our influence potent. We do not here meet as members of a guild or trades union; demanding a fixed and uniform compensation for services by members of our craft, but upon a broader, higher plane. As learned professional men we are associated for "the professional improvement of our membership, the encouragement of social intercourse, and the advancement of engineering in all its branches."

When we meet here, this feeling of pride in our profession and of fellowship in our work is aroused, and from the local Club should emanate the sentiment which should induce every engineer to unite with every other engineer; each yielding a part of his time and a part of his labor in upholding the rights, maintaining the honor, extending the influence and obtaining the recognition, legally and socially, of the profession of which he is a working member. By this means only can we obtain that acknowledgment and honor for our calling to which it is entitled by the good work, the brilliant achievements, and great benefactions given to the world by engineers in this century of progress.

Being modest men we are not accustomed to making arrogant demands. Laying no claim to statesmanship, we seldom appear in legislative halls or in political assemblies; but we are conscious of possessing as great intellectual powers, as good executive abilities, as effective business methods, and of using as close and exact forms of reasoning, as do our fellow men in any profession. We therefore feel that we owe to each other that courtesy and aid which will show to the world that we are cultured gentlemen, co-laborers in the broad field of our profession; not envious competitors within the narrow limits of a common trade. The growth of this feeling is to be fostered in the local Club, strengthened in the national organizations, and it will permeate the entire membership, uniting us by professional ties into a solidarity, which, by its respectability, its intellectual power, its practical utility, will cause it to be recognized as the segregation, the union, of the active working leaders in human progress.

We ask no statutory recognition. The tyro might appear before a legally-constituted examining board and be authorized to affix "C. E." to his cognomen, or the careless dullard might be given the same privilege because "for lo, these many years" he has been wasting the substance of his employers and dishonoring the title which he claims by reason of his long experience. No! It is in our own associations, among our fellow workers, where we can describe what we have accomplished with the appliances and means at our disposal, that we ascertain whetner or not we are worthy of honor. This fact should unite us more closely in our brotherhood. Knowing it to be our only bond of union, should cause each one to feel that to his professional Club or Society he owes the duty of maintaining its honor, upholding its position and extending its influence.

THE DIVISION ENGINEERS on the Nashua aqueduct for the water supply of Boston, Mass., described in our issue of Feb. 25, are as follows: Division No. 1, comprising sections 2, 3, and 4, Mr. Horace Ropes; Division No. 2, comprising sections 5, 6 and 7, Mr. Alex. E. Kastl, M. Am. Soc. C. E.; Division No. 3, comprising sections 8, 9, 10 and 11, Mr. Charles E. Wells, M. Am. Soc. C. E.

*Extract from an address by M. D. Burke, Retiring President of the Engineers' Club of Cincinnati, to Chas. E. Lindsay, newly elected President, delivered at the Annual Meeting, Dec. 17, 1896.

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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

A very instructive account of a grade-crossing collision between a railway train and an electric car is given on another page of this issue, and the discussion of the methods for the prevention of such accidents is one of the best that has ever been made. We believe the suggestion that electric railway companies should be given the power to condemn land adjacent to a crossing for the purpose of deflecting their line and erecting an overhead bridge across the steam railway tracks is a proposal of much merit. By giving the approaches to such a structure a grade of 8 to 10%, the length of the necessary viaduct approaches would be very small, and the work would be correspondingly inexpensive.

We very lately made some comment upon a proposed Nebraska State Board of Engineers; and later explained that the anomalous character of the board was due to the constitution of the State which forbids the creation of new executive offices by the Legislature. Another bill of the Legislature of Nebraska, Senate bill No. 244, is now before us, which is even more objectionable than the one referred to. It is an act to amend certain sections of the Compiled Statutes of 1895, and provides that the State Board of Irrigation "shall elect a secretary and assistant secretary, one of whom shall be a civil engineer having a practical 'knowledge of irrigation'." Another section would be amended so as to provide a salary of $2,000 per annum for the secretary and $1,200 for the assistant secretary. Further amendments provide that plans, specifications and estimates for any proposed irrigation canal and works must be prepared by a competent civil engineer and filed with the secretary of the State Board of Irrigation, "who shall immediately make, or cause to be made, an examination of said plans, specifications, maps, estimates and the lands embraced within said district." If the secretary finds the plans feasible, practicable and reasonable, he will approve them and a permit for the work shall be issued by the State board signed by the president and secretary of the board.

The peculiar features of this proposed new law now pending lie in the fact that the Board of Irrigation is made up of State officers named in the constitution, who practically have no knowledge of the business in hand; just as the Governor, Secretary of State and Attorney-General were to form the State Board of Engineers recently objected to. In both cases a secretary was to perform the actual technical work required. But in this case we have information that the whole purpose of this Bill No. 244 is to permit the appointment of a lawyer as Secretary and relegate the engineer to the assistant secretaryship; and the law is so framed that this can be done, as the secretary "may cause" the examination to be made, in case he is not fitted to make it himself. As we understand it, the State Engineer of Nebraska is now officially the Secretary of the State Board of Irrigation; and it is bad enough to place the supervision of the irrigation system of Nebraska in the hands of a man who is simply the secretary to a board knowing nothing about irrigation, and yet clothed with the power to pass judgment upon technical work of this character. But if this is the law now, the only purpose of the amendment can be to still further degrade the office and to place this important responsibility upon a $1,200 assistant to an assistant. As before said, it is difficult to conceive of a more incongruous measure than the administrative law of Nebraska, and the State constitution sadly needs amendment. But even under present conditions this amendment proposes a wide departure from previous laws defining the duties of the secretaries of these curious state boards, and it is an abortion for which there is no honest or valid argument.

The discouragements under which many a capable and hard-working head of a city department labors are illustrated in the annual report of Mr. John C. Trautwine, Jr., Assoc. Am. Soc. C. E., Chief of the Philadelphia Bureau of Water, an advance copy of which has been sent us. In alluding to the matter, it must be understood that the report is not one filled either with complaints or expressions of discouragement. It is simply a straightforward statement of the work and condition of the department during 1896. While the water supply of Philadelphia presents many physical problems difficult of solution, these do not seem to be the chief difficulties confronting Mr. Trautwine. He has studied these physical problems and offered solutions for many or all of them. The real obstacle in the path of an improved and thoroughly efficient water supply for Philadelphia is the failure of the city councils to provide funds and authority for making needed improvements. For instance, Mr. Trautwine asked for $2,835,150 for use in 1896 in making extensions and improvements to the works, of which $1,819,150 was for additional pumps and supply mains. Not a single dollar was granted by councils for these purposes, but necessary sums were provided for repairing reservoirs practically useless through faulty construction. Moreover, councils has again refused to make appropriations for extensions, so that 1897, as well as 1896, will go by without any of the ordinary extensions necessary to keep up the efficiency of a large water-works system. But this is not all. While appropriations are refused for needed enlargements of the system, no authority is given for the curtailment of waste, which has increased to such an extent that the daily per capita consumption in Philadelphia is 235 galls. Not a meter can be bought for placing on domestic services and the authority to buy meters for other services is of little use, since the consent of the consumers must be obtained before meters can be placed. Naturally, the man who is using or wasting so much water that a meter would be of the greatest benefit to the city will refuse to have a meter on his premises.

The city has long been in need of a purer supply, but little or no real progress has been made in obtaining it. True, councils have appropriated $3,000,000 for a filtration plant, but it is an appropriation of glittering generalities, which must be followed by other more specific ones, while the courts must yet decide whether the bonds can be legally issued. It has been urged that practical studies of filtration should be at once inaugurated, to learn what kind of works are most suited to local conditions. To this end, an attempt has been made, but failed, to secure $250,000 for the construction of a good-sized plant at one of the several pumping stations; a plant with a capacity of several million gallons, operated as any other filter plant is, and really experimental only in the sense that instead of building works for the whole supply at once, a smaller plant would be installed first, in order to secure and profit by experience for the balance of the work. Yet even this has been impossible.

The practical relation between filtering and metering the supply is well shown by Mr. Trautwine, as follows: Assuming the expense of a filter plant at $15,000 per 1,000,000 gallons for construction and $3 yearly for operation the cost of filtration works to handle the supply actually furnished in 1896 is $3,525,000 for construction and $257,325 for operation. If the consumption were reduced by meters from the present per capita rate of 235 gallons per day, to even 120 gallons, which latter in many cities would be considered criminal waste, the cost of both construction and operation, Mr. Trautwine estimates, would be reduced practically one-half. If the present increase in rate of consumption goes on until 1910, Philadelphia will be using 450 gallons per capita. The estimated cost of a filter plant to handle this amount of water is $6,750,000, with $492,750 per year for operation. All the above estimates are exclusive of land for the filter plant, and also of interest and sinking fund on the investment.

What Philadelphia is coming to if it persists in its present course, we shall not venture to predict. Why its city councils pursue such a policy as they do regarding the city water supply (and its attitude regarding the city gas works is perhaps as bad, or worse), we leave to the citizens of Philadelphia to find out—if they can.

THE SANITARY PROTECTION OF THE INLAND WATERS OF NEW JERSEY.

We are pleased to note that there are fair prospects of an addition to the list of states which have taken steps to preserve the purity of their inland waters. Massachusetts, Connecticut, New York and Ohio are already doing good work along this line, although in different ways and with varying degrees of success. New Jersey has long needed to take vigorous measures to stop the rapidly increasing pollution of many of its beautiful streams, but until last year it has shown almost total indifference to the subject, at least so far as effective legislation is concerned. This is the more remarkable, since that state is largely habited with a class of people who have gone to it because of its natural beauty and healthfulness, qualities which it owes largely to the very streams which are being so ruthlessly polluted.

Many of the streams of New Jersey are yet in almost as virgin a state of purity as when the solitary Indian followed their sinuous courses in search of bird, beast or fish, but even these need sanitary protection against the ever-increasing inroads of summer visitors, permanent country homes and industrial establishments of many sorts. In the more thickly peopled suburban residence or manufacturing sections of the state the stream pollution ranges all the way from its initial stages, serious only because of its prospect in the future, to vileness almost indescribable.

An example which, with its headwaters and lower reaches, well serves to illustrate the two extremes, is the Passaic River. It is the revolt against the further destruction of the natural attractions of this great and beautiful drainage area which has given rise to the first substantial step towards the reclamation and conservation of the purity of the inland waters of New Jersey.

The rivers in the New Jersey uplands which combined to form the Passaic are the Ramapo, Wanaque, Pequannock, Rockaway, Whippany and the upper Passaic. These, with the ponds and lakes in their areas, are in that beautiful highland region of New Jersey, which is and well may be the pride of the state. As yet these streams are practically unpolluted, as is the case with the main river as far down as Paterson. But already pollution begins to be imminent at some points in the upper drainage area, and it should be stopped while this may easily be done. Below Paterson the condition of the Passaic is al-

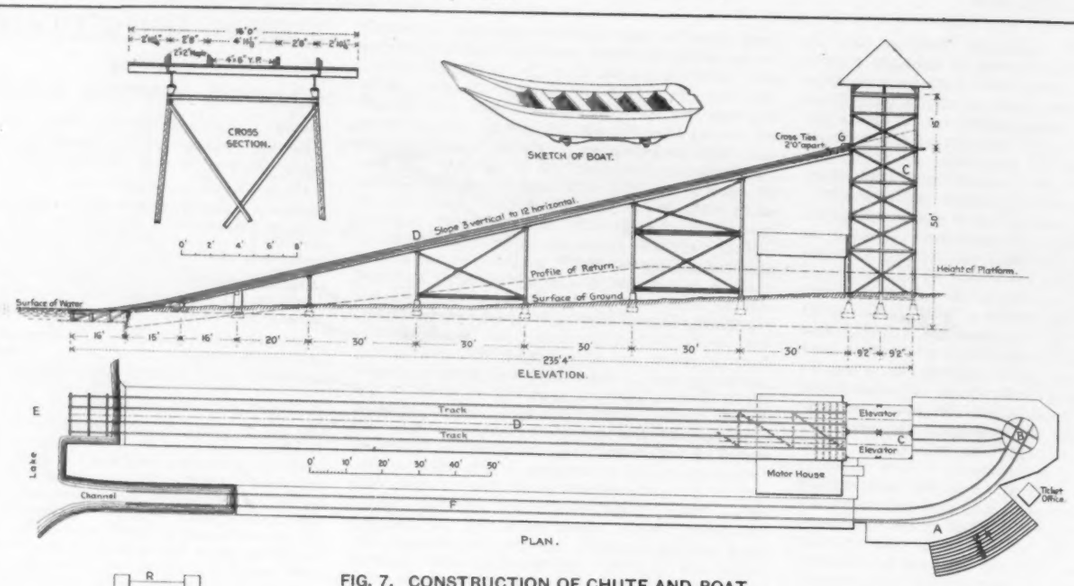
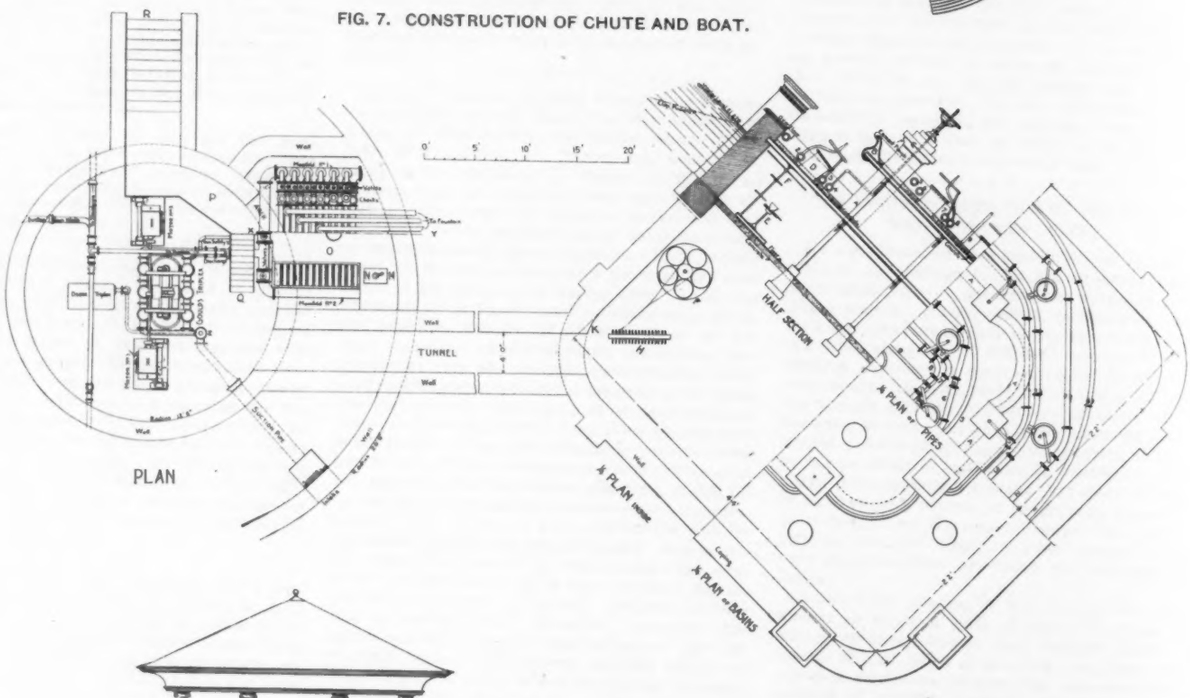


FIG. 7. CONSTRUCTION OF CHUTE AND BOAT.



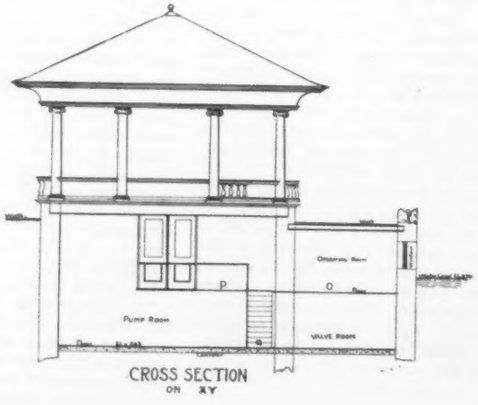


FIG. 3. PUMP HOUSE AND ELECTRIC FOUNTAIN.

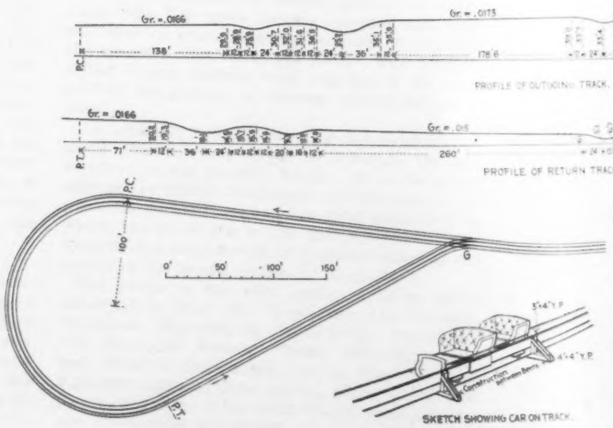


FIG. 8. TOBOGGAN SLIDE

AMUSEMENT FEATURES AT WILLOW GROVE PARK

Messrs. Wendell & Smith, Managers.

FIG. 6. VIEW OF CHUTE.

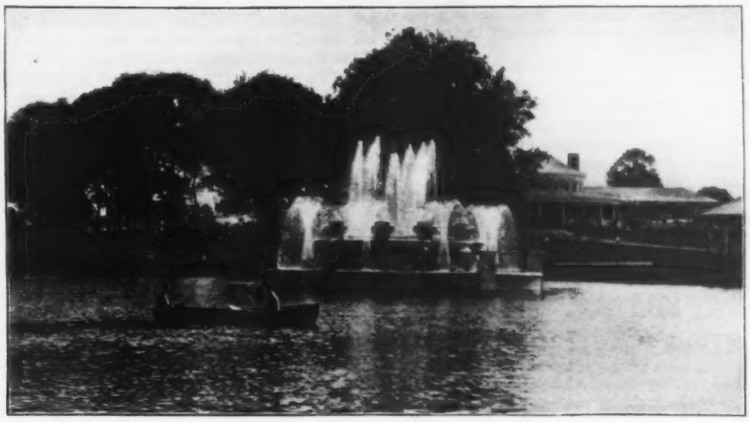


FIG. 4. VIEW OF ELECTRIC FOUNTAIN.

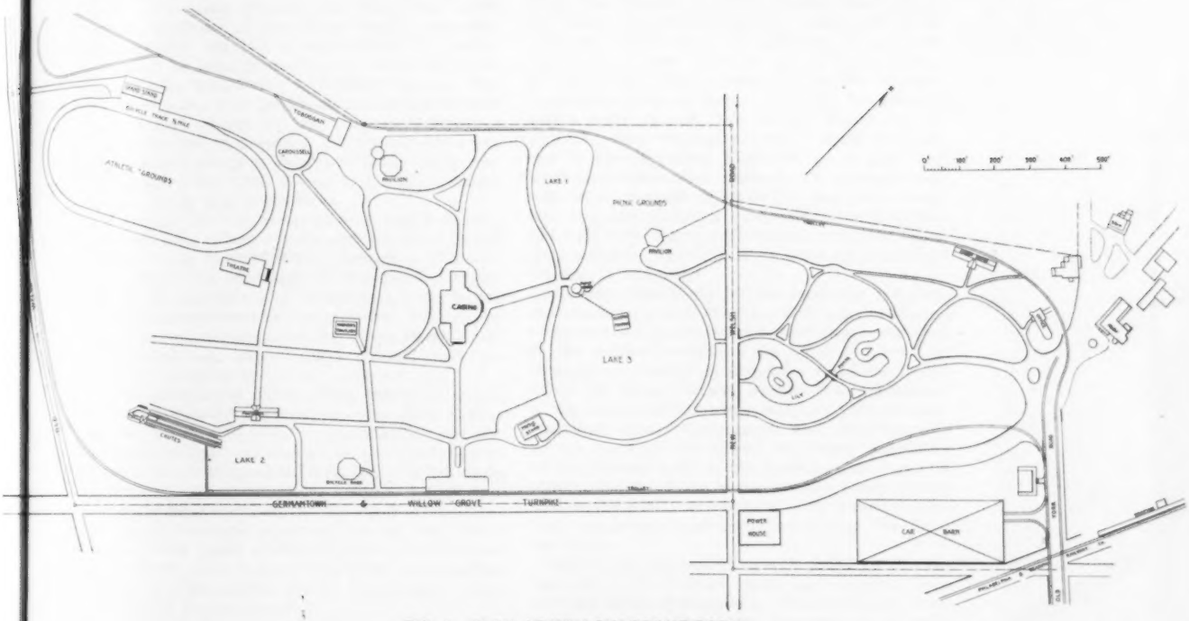
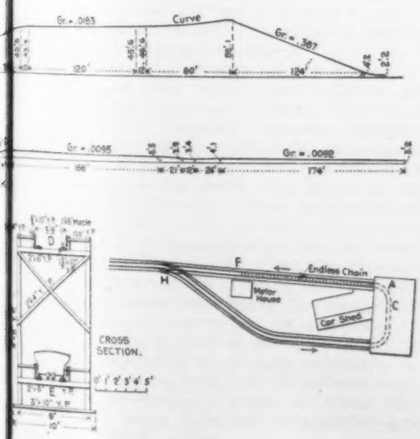


FIG. 1. PLAN OF WILLOW GROVE PARK.



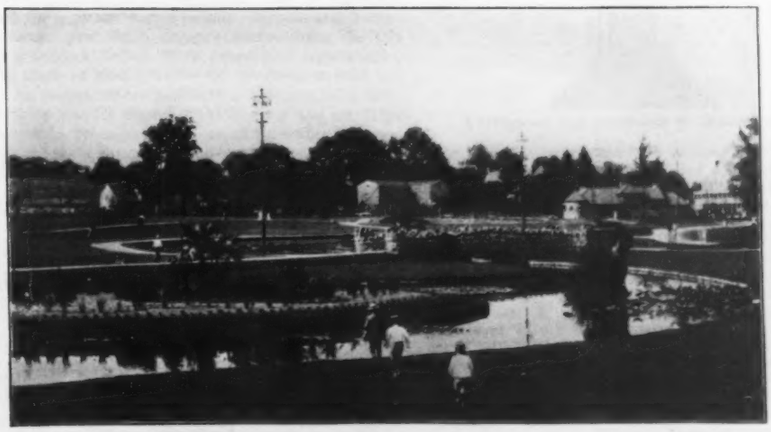


FIG. 2. VIEW OF LILY PONDS.

VE PARK, PHILADELPHIA, PA. (UNION TRACTION CO.)

Chester E. Albright, Engineer.

ready serious. The lower valley is naturally a beautiful one, but the river carries so much sewage that fish and pleasure craft have largely abandoned the stream, and the spacious and pleasant homes along its banks are many of them deserted. Even the manufacturing and commercial industries are carried on at a disadvantage, and in some cases at a loss, because of the pollution of the stream, which at times is very offensive to those working near or on it, and does not furnish, as it once did, water suitable for industrial purposes.

This interference with industry, homes and pleasure seekers along the river is a direct financial loss to the state in a variety of ways, to say nothing of its deleterious influence upon health, either directly, through the breathing of impure air, or indirectly by depriving some of outdoor pleasure possible here, but not obtainable elsewhere. As a matter of health, the most serious question in connection with the Passaic and many other streams of the state, is the preservation of the purity of public water supplies. The Passaic drainage area is the natural source of water supply for Newark, Jersey City and a host of smaller but rapidly growing municipalities near New York. The lower Passaic has long been unfit, without purification, for water supply purposes, and has now reached a stage where the pollution must be greatly lessened to make the river tolerable for those living or working near it. The upper Passaic, with judicious management, may be kept pure enough for any purpose to which it may be desired to devote it, but already there are some danger points at hand, and many more may spring up at any time if wise and firm measures are not taken to prevent them.

A solution for the whole Passaic has been presented in an able and commendable manner in the report of the Passaic Valley Sewerage Commission, abstracted elsewhere in this issue. Briefly stated, it is proposed to establish a commission, through appointment by the governor, with power to divert the sewage from the lower Passaic and to establish and enforce rules against pollution in both the upper and lower valleys.

The proposed act under which this work would be done is equally applicable to any other stream of the state, whenever a commission like the present one has been created by the legislature to study such stream and declares its pollution to be a nuisance and a menace to health. But it does not fully meet the needs of the other streams because: (1) Nothing whatever can be done for a stream until public sentiment becomes so aroused as to secure the necessary legislative commission; and (2) the act applies only where a nuisance and menace to health exists.

The lower Passaic became simply intolerable to the people in the valley before they began the public agitation which led to the appointment of the present commission, while nearly two years has elapsed since the agitation began, and only a report telling how to abate a nuisance thought unbearable in 1895 is the result of the effort which was then begun to stop it.

Instead of waiting until a stream is polluted almost past redemption, statutes should be enacted to prevent pollution from the start, and instead of requiring a separate legislative act and investigating commission for each stream, powers for the preservation of the purity of the inland waters of the whole state should be vested in a permanent body. These powers should be judicial and police powers, leaving the construction of necessary sewage disposal works to local bodies, either those of existing municipalities, or where a number of towns and cities are involved, to a special commission, like that proposed in the act under discussion. In expressing these opinions we are not so much criticising the recommendation of the Passaic commission as pointing out how its work may be rendered more valuable to the state as a whole for whom the commission really made the investigation—gratuitously, it may be added.

The engineering features of the report need no discussion. The commission employed Mr. Alphonse Fteley, M. Am. Soc. C. E., as consulting engineer, and the late Chas. A. E. Jacobsen as resident engineer. The recommendations of the engineers, which were adopted by the commission, were for joint disposal, and for discharging the sewage in a volume of tide water sufficient for its disposal in its crude state, rather than attempting to purify it and discharge it nearer at hand. Local conditions, fully set forth in the report, seem to fully justify these conclusions, both from the sanitary and financial standpoints. Joint public works for close-lying municipalities can often if not generally be carried out far more cheaply than isolated works, and it is becoming almost a maxim among engineers that tide-water disposal is the best solution of the sewage problem, where the volume of water is sufficiently large to prevent a nuisance and the expense is not prohibitory.

Boston and the adjoining municipalities have already carried out two large joint systems of sewage disposal. A like plan has been recommended for the Bronx River valley in and above New York city. But the people of the Passaic valley need not go outside their own limits to find examples of the economy of joint disposal. Orange, Montclair and Bloomfield are already contributing to the pollution of the Passaic River through a common trunk sewer discharging just above the Newark city limits, while East Orange has abandoned its purification works and sends its sewage to the river through one of the Newark trunk sewers. In other public undertakings it may be noted that a large part of the territory in question gets its water from the Pequannock works, built by the East Jersey Water Co. for Newark; that the Essex County Park Commission is now spending $2,500,000 on a park and boulevard system for Newark, the Oranges and other municipalities in Essex Co.; that this county has long had a county road system; and that it has long been common for towns, cities and counties, separated by streams, to build and maintain bridges in common.

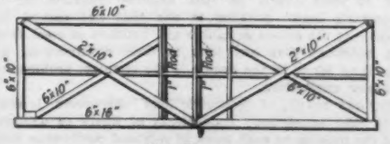
The important thing for the people of the Passaic drainage area to do is to carry out the scheme recommended, or devise and execute a better one, at the earliest possible date, while the state of New Jersey, having provided for restoring to decency its worst stream, should take advantage of the good work and suggestions of the Passaic Valley Sewerage Commission and establish and put in operation machinery to prevent repetition of the Passaic evil on the Raritan, Rahway and other streams of the state, always remembering that in the purity and beauty of its inland waters lies, to a great degree, the health and wealth of the state.

Other commonwealths should profit by the experience of the Passaic valley and conserve their streams before it is too late. Massachusetts, New York and Ohio require the approval of all plans for sewerage systems by their respective State Boards of Health before construction is started. New York has enacted legislation which makes possible the establishment of rules for the sanitary protection of any drainage area in the state used for a public water supply. Illinois and Pennsylvania now have comprehensive bills on the same subject before their respective legislatures. The close of this century of progress should see all the states, where population is dense, with laws on their statute books providing for the effective protection from pollution of their water courses, and, what is equally necessary, an effective system of enforcing these laws.

LETTERS TO THE EDITOR.

A Puzzle in Bridge Stresses.

Sir: I enclose a sketch of a curiosity in highway bridges recently built in Caldwell Co., N. C. The 6 × 10-in. braces are mortised into the posts, and were evidently expected by the builder to transmit the strains in some way to the abutments. The 2 × 10-in. ties are spiked to the upper and lower chords by three nails at each joint. The bridge has a span of about 55 or 60 ft.



Side Elevation.

A Truss for a North Carolina Highway Bridge.

Truly yours,

Edwin Mitchell, Assoc. M. Am. Soc. C. E.

5 E. Lexington St., Baltimore, Md., Feb. 17, 1897.

(We suggest that the students of bridge stresses in the engineering schools may find it a good exercise for their analytic powers to determine the point where failure would occur if the structure were loaded to the breaking point.—Ed.)

The Tube Mill: A Correction.

Sir: In the report of the Annual Meeting of the Association of German Portland Cement Manufacturers, published in Engineering News of Feb. 25, an error was made in regard to the amount of flint balls which require to be introduced to make up for the wear of the balls. The statement should have read:

"It is found that about 2 lbs. of flint balls must be introduced for 80 barrels of cement ground."

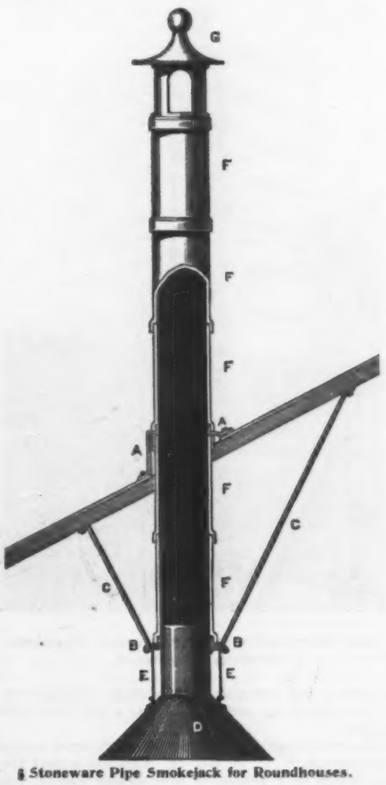
By an error in proof reading, "80 lbs." was substituted for "80 barrels," making the statement very unjust as to the well-known performance of the mill.

Yours truly, S. B. Newberry.

Sandusky, Ohio, March 2.

Stoneware Smokejacks for Roundhouses.

Sir: We notice on p. 146 of your issue of Feb. 18 a cut representing a wooden smokejack for roundhouses. We know nothing about these jacks, but desire to call your attention to the enclosed circular describing our smokejacks, made of vitrified glazed stoneware. These jacks we have been making for about 20 years, though we have never patented them, and we have furnished large numbers to the leading railways in the country. They are made from a special composition of fire clays, and are salt glazed, making them indestructible. All the railways in New England have used and are now using them on every new roundhouse they build. The Pennsylvania R. R. and the New York Central R. R. have used a very large number, as have also a great many railways in the south and west, and we have yet to hear of a single case where they have been injured or destroyed except in a few cases where the wind guard on the top has become detached and was broken in falling.



§ Stoneware Pipe Smokejack for Roundhouses.

Yours very truly, Geo. C. Dunne,

Manager, Portland Stoneware Co.

42 Oliver St., Boston, Mass., Feb. 25, 1897.

(The smokejack referred to is shown in the accompanying cut. The roof-saddle, A, is a casting of rectangular form, having a flange surrounding the sides at a proper angle to suit any pitch

of roof, and having top and bottom collars to fit the terra cotta pipe. This roof-saddle supports the pipe placed above the roof, and steadies and makes connection to the pipe below the roof; this latter pipe being supported by the ring-casting, B, and rods, C, from the roof. The sheet-iron bell, D, with its short section of smoke-pipe telescoping into the terra cotta pipe, is supported and held in position by the ring, B, and bolts, E. The lengths of terra cotta pipe are marked F, and the smoke-jack is surmounted by a wind guard, G, also made of vitrified clay.—Ed.).

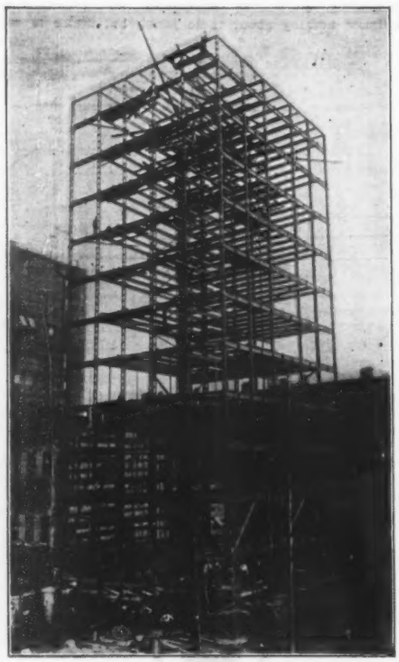
Bridge Accidents in 1896.

Sir: The list of bridge accidents in the United States and Canada during the year 1896, published in your issue of Feb 11, needs correction in the following particulars:

The accident reported as occurring on the C. B. & Q. R. R. at Coin, Ia., on Dec. 3, should be stricken out. A derailment attended with slight damage did occur near there on that date, but had nothing to do with any bridge except slightly damaging the ties at one end of a trestle.

The highway bridge at Canton, O., which let a traction engine through on July 13 was not a wooden bridge, as reported, but an iron one, with wooden floor system. The floor broke through, but the trusses did not fall.

A similar accident, not included in the published list, occurred to a similar bridge at Watertown, N. Y., on Oct.



Steel Framework with Gray Columns; Wyandotte Building, Columbus, O.

14, when a road roller broke through the wooden floor of an iron truss bridge and dropped into a mill race, killing one man.

Another highway bridge accident not reported occurred at Nicholville, N. Y., on May 11. This was a pony Howe truss bridge with suspended floor beams, one of which gave way at the suspension bolt, dropping a loaded oil tank drawn by two horses. Yours truly,

Chas. F. Stowell.

Albany, N. Y., March 6, 1897.

Sir: Among the number of bridge accidents published in your issue of Feb. 11, you give one on the Norfolk & Western R. R., June 6, a wooden trestle, at Bedford City, Mo. This bridge was an iron viaduct and not wood; was near Bedford City, Va., and not Bedford City, Mo. The Norfolk & Western R. R. lines do not enter Missouri. Mr. Stowell has doubtless been given the wrong information. M. F. C.

Lynchburg, Va., Feb. 13, 1897.

(The printing of Mo. instead of Va. was a typographical error.—Ed.)

Pennsylvania Highway Legislation.

Sir: Your note on "A Good Roads Bill for New York," in your issue of Feb. 11, 1897, attracts my attention, as, about eight years ago, I was appointed one of a committee of the Engineers' Society of Western Pennsylvania to frame a better road law for the state of Pennsylvania. As a preliminary step I attempted to find out what the road law of Pennsylvania was. After a great deal of trouble I found, by good authority, that previous to 1874, when the present constitution of Pennsylvania went into effect, there had been enacted by the Legislature, as follows:

Special laws relating to:

Plank roads and turnpike companies	2,865
Common roads	705
Toll bridges	780
Ferries	264
Total special highway laws	4,614

All these laws authorized the collection of money for use on highways in some form, and no one can tell how many special laws have been enacted since 1874. And yet, with all this legislation, the common roads of Pennsylvania are worse, I think, than those of any other civilized region.

I made a careful examination into the cost of this legislation and its results, and find about as follows:

Enacting 4,614 special laws, say	$1,000,000
Road tax levied, $4,000,000 for 50 years	200,000,000
Loss of one-half useful horse-power for 50 years, say	1,983,629,750
Total	$2,184,629,750
Add as much more to above for the toll collected on 2,865 plank roads and pikes, 780 toll bridges, 264 ferries, say	2,184,629,750
Total cost	$4,369,259,500

As the great bulk of this enormous aggregate of money was collected from the farmers it is little wonder that "farming does not pay." Yours respectfully,

Arthur Kirk.

Pittsburg, Pa., Mar. 3, 1897.

(As the great majority of the special road laws were enacted to meet special requirements, and are now dead, or should be, the list given is interesting only as showing the vast amount of labor that has been expended without any practical and good result. The record is common, doubtless, to every state, and only emphasizes the necessity of wiping off from the statute books these obsolete laws and replacing them by comprehensive highway legislation, framed to meet present requirements. While the aggregate of money wasted in this past effort to build and maintain roads is doubtless enormous, we can not approve as correct the figures set down by Mr. Kirk. Plank roads and turnpikes, ferries and bridges answered a good purpose in their day and doubtless made a fair return upon the investment in them. They were a necessity before the days of railways, and, as a rule, highways were better than they are now. As to the cost of legislation and the loss of animal power due to bad roads, neither can be even approximately estimated; and in figuring upon the latter item it must be considered that other considerations besides that of legislation have delayed the general construction of perfect highways in this country. The present common objection that good roads cost too much to build had still greater force a generation ago.—Ed.)

Steel Columns and Eccentric Loads.

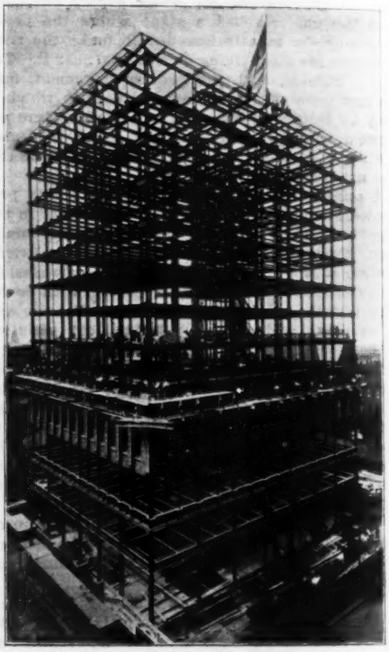
Sir: Replying to your criticism of "Gray" columns and other forms of columns in the issue of Engineering News of Feb. 25, 1897:

The "Eccentric Load" question has been gone over and over by engineering societies, engineering papers and individuals, until, if we are to judge from the literature on the subject of steel skeleton building construction, or from the statements of the principal discussers of the topic, there is only one problem in this construction. This being the case, I desire to call the attention of the public and yourselves to the fact that eccentric loads have always been encountered and provided for in building construction; and further, that eccentric loads have been transmitted on exactly the same lines as employed in the Gray columns, in a proportion of about 10,000 to 1; the 1 being a use of the truss element (triangle) for such transmission plus the occurrence of continuous webs. A modern example is furnished by any bicycle frame. The truss element is absent as well as any continuous web, yet a 200-lb man rides over the American roads, supported by 10 lbs. of steel frame. In steel skeleton construction the "eccentric load" problem is one that has caused less trouble to the actual designers and builders of steel skeleton buildings than any item in their construction, and providing for it in the design is the simplest problem the designer encounters.

For the benefit of "eccentric load" discussers, I would state that satisfactory connections of floors to columns, and the making of each stack of columns continuous, from the bottom to the top of a building, produces a steel skeleton absolutely independent of walls, floors, or partitions, and this is the problem that steel skeleton designers had to solve. Economical continuity and economical floor connections, which do not interfere with the architectural design, have been the other side of the problem.

During a ten years' experience in steel building work, in which time nearly every form of column known has been used, no form of continuous web or latticed column has fulfilled the above conditions. As to continuous webs, or latticing to provide for eccentric loads, they could be as readily applied to the Gray column as tie plates, and would be used, if it had not been demonstrated in over $16,413,000 worth of Gray column buildings, that webbed or latticed columns did not prove as satisfactory, either in their construction or use in buildings as the tie-plate construction. This is true, in spite of the fact that webbed or lattice columns require very much less detail metal to produce a column shaft than the amount used in tie-plate construction.

In the Gray column tables published in our handbook, tie plates are specified for approximately four times the reaction of a 20-in. I beam fully loaded, and 20 ft. in length, the length of the column being an ordinary story height, or about 12 ft. On p. 43 of the handbook, Rankine's eccentric load formula is published. This formula is applied correctly where the floor beams, or girders, rest on shelves or cap plates, but is greatly in excess of requirements where the intent of the Gray column construction is carried out, as in the buildings illustrated. Here all connections of beams to columns, girders to columns and the different sections of the columns to each other are stiff joints with no shelves or cap plates. With connections made in this manner, an eccentric load can produce



Steel Framework with Gray Columns; Guaranty Building, Buffalo, N. Y.

no bending in a column except by deflecting the floor member, an entirely different condition from the ordinary shelf method. One particular feature of the use of the Gray column in buildings is that the same diameter of column used in the basement can be used in the attic, and is so used with practically no waste of metal.

This simplifies the construction and is economical at the same time, for this reason: The floors as they go up are practically made of the same sized beams. Each succeeding story of columns, however, requires less section; if, therefore, a column is used which has to be reduced in diameter as the section reduces, and in the upper stories of the structure, four, six, and even eight 15-in. I beams are specified to be connected to a column 6 ins. in diameter, the designer can do only one of two things, either build shelves containing as much weight as the column shaft, or rest the columns on top of the beams or girders. Both of these methods are to be seen at present in New York and Philadelphia. The expense and difficulty of keeping structures put up according to the latter method from winding or leaning are not encountered in the buildings illustrated in the accompanying cuts, for, as was stated above, the steel work here constitutes a thoroughly independent structure

In conclusion, I would call attention to eccentric loading in bridges and the type of latticed construction employed, which appears to have prompted the insistence that the same lattice construction must be employed in buildings. Take the connection of a floor beam to a latticed channel

post, a very common example. Here the eccentric floor-beam load is divided between the channels by batten plates or by a diaphragm. The same is true of the method of providing for the eccentric load of an intermediate top strut. This is the same transmission as is employed in the Gray column.

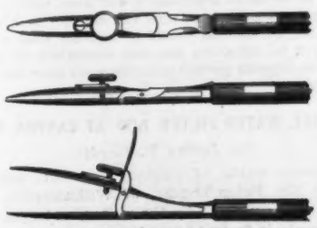
I desire to correct an error in your statement as to the distance apart of the tie plates. Reference to the Gray column handbook will show that this distance is never greater than 2 ft. 6 ins. c. to c. of tie plates.

Yours truly,
J. H. Gray, C. E., M. Am. Soc. C. E.

1326 Chestnut St., Philadelphia, Pa., March 5, 1896.

A RULING PEN WHICH CAN BE CLEANED WITHOUT ALTERING ITS ADJUSTMENT.

An ingenious device has been put upon the market by Theo. Alteneder & Sons, of 945 Ridge avenue, Philadelphia, in the form of a lever ruling pen that can be cleaned without altering the adjustment, or, in other words, without touching the screw. This pen is made in one piece with the upper blade in the form of a spring which tends



An Easily Cleaned Ruling Pen.

to constantly press the points together. The adjusting screw is fitted to the upper instead of the lower blade, as usual, and merely bears against the inner face of the latter, and thus separates the points.

The other novel feature is a lever, with parallel arms, pivoted to the lower blade and provided with a bar connecting the two arms and located between the two blades. By lifting this lever the bar raises the upper blade and holds the two blades apart for cleaning, as shown in the illustration. A 5-in. or 5½-in. lever pen of this type with an ebony handle costs $2.50.

THE PRESERVATION OF STRUCTURAL TIMBER.

By John D. Isaacs.*

The importance of the preservation of timber for engineering, mining, and other purposes has long been recognized. This subject has received much attention among civilized nations during the past two thousand years. A great variety of preservative agents, and of methods of treatment, have been tried, tested, and abandoned. Many processes have given such promise of success as to apparently justify large expenditures of money in their development, and a few have risen to commercial importance; but most methods, when attempted on a large scale, have proved failures.

It is not surprising, in view of the general interest in this subject, and of the prevailing ignorance of its history, that long known and abandoned processes are constantly being revived, and not infrequently the enthusiastic inventor succeeds in sinking his own and other people's money in some project, when an investigation of the state of the art would show that the assumed discovery has long been anticipated.

For these reasons, it is thought advisable to preface a description of practically successful processes in use with a partial enumeration of those tried and abandoned. Besides these, there are some processes which, under certain conditions, are really useful, though not of general application. A brief description of these will also be given.

Among the Greeks, and later the Romans, the following preservatives were used: Oils, tars, resins, and pitches from various woods. These were usually applied superficially, but sometimes holes were bored in the timber to assist penetration. Also, crude soda, common salt, sodium sulphate, and bitumen. Sometimes timber was first soaked in a soda or salt solution, and afterward boiled in bitumen. This evaporated the moisture, crystallized the salt, and supplied an exterior protection, which prevented the washing out of the salt, as well as furnished mechanical protection against exterior attack. This last method was probably used as a protection against the "teredo navalis," with which the ancients were well acquainted.

Among the many preservatives tried during the last century, and early in this, the following may be mentioned: Copperas, bluestone, nitrate of silver, corrosive sublimate, sulphate of zinc, carbonate of soda, caustic soda, arsenic, barytes, common salt, quicklime, alum, soap, resin, coal tar, vegetable oils, fish oils, vapors of oils, powdered charcoal, charring, etc. (See "Preservation of Timber" by Boulton, Van Nostrand, 1885; "Preservation of Timber" by Chapman, London, 1817.)

Scarcely a month in the year elapses that some one of the above substances is not brought to the attention of the writer, sometimes with much secrecy, as a great discovery. It is undoubtedly a fact that, under favorable circumstances, some of the above preservative agents answer the purpose fairly well, and the inventor can usually show a fairly sound piece of timber so treated which has been "alongside of" a very much decayed piece not so treated for —— years. Usually the time and extent of the experiment are both limited, and the fact overlooked that the same difference in lasting qualities is observable between two sticks of different periods of growth, times of felling, etc., when neither has had any preservative treatment.

Among later processes the following may be noted:

Lostel's Process.—Used in France for the preservation of thin material, such as lagging, for mining purposes. The plank is piled in tanks, with strips between. It is then covered with quicklime, which is gradually slacked with water. Time of treatment required for 2-in. plank, about one week. It is said to work well, and it materially hardens the timber.

Koug's Process.—The timber is packed in a vertical, closed retort, and filled three-fourths full with sodium carbolate. It is then boiled by the introduction of a jet of live steam into the carbolate. This is continued until the retort is filled by condensation of the steam. The timber is soaked in the hot liquid for ten to twelve hours. The liquid is drawn off, and the timber finally washed with a steam jet. Crude sodium carbolate may be made by the action of a hot solution of caustic soda on coal tar.

Hock's Process.—The timber is first seasoned by the use of steam in a closed retort. It is then saturated with a solution of paraffin in volatile kerosene; the surplus drained off; the solvent driven from the timber by heat, and recovered in a condenser for future use. This leaves paraffin in the pores of the wood. If the drying is thoroughly done, the process is said to be preventative of dry rot.

In Holland a superficial protection has long been in use for the protection of large timbers, piles, etc., used in sluices and flood-gates. The surface of the timber is covered with a mixture of tar and pitch, applied hot, over which is sifted powdered shells, forge scale, and sea sand.

Payne's Process.—The timber is impregnated, in closed retorts, with a solution of sulphate of iron (copperas), and afterward treated with lime water. This forms an insoluble exterior coating of gypsum. Instead of lime, alkaline carbonates, such as that of soda, have been used.

There are many mixed processes, similar to the last, which consist of an injection of one substance, followed by a second. In such cases the first is usually the preservative proper and the last is intended to act as a seal, to prevent the evaporation or the leaching out of the former. But in some processes both injections are preservatives. The following are some of this class:

Name of process.	First injection. Solution of—	Second injection. Solution of—
Jacques	Soap	Tar acids
Richards	Common salt	Alum
Muller	Phosphate of soda	Chloride of barium
Hatzfeld	Tannin	Acetate of iron
Krug	Soda	Creosote
Paulet	Sulphate of copper	Creosote
Wellhouse	Chloride of zinc and glue	Tannin

The only one of these now in practical use is the Wellhouse process, which is really a variety of burnettizing, hereafter described.

Vulcanizing.—This is a process peculiar to itself. The timber is heated in closed retorts, under pressure, without seasoning, to a temperature sufficient to transform the sap into various organic acids, wood creosote, etc. The difficulties with this process seem to be two: First, while the preservative constituents may be sufficient in quantity to act somewhat like creosote, if they were concentrated near the surface, they are too much distributed for their quantity throughout the timber; and, second, wood creosote, which is a part, and probably the most important part, of the results of the process, is not an effective preservative of wood.

The following is a brief statement of the theory of timber preservation as now understood: Timber may be destroyed in two ways:

First.—By being eaten away or consumed by external attack, such as that of the "teredo navalis," "limnoria terebrans," ants, bugs, etc. Almost any dense, pitchy substance, insoluble in water, and so applied as to adhere firmly to the exterior of the wood, without openings or cracks, will, in a measure, prevent destruction from this cause. But those preservatives are the most effective which contain coagulents of albumen, since the spawn of most of the enemies of timber are albuminous cells, to which contact with such preservatives means instant death.

Second.—By decay, rotting, and dry rot. Like most vitalized bodies, timber begins to decay when deprived of life. This process is brought about by the ever-present myriads of germs in the atmosphere. In this process the nitrogenous portions of the sap, such as albumen, play an important part. There are, therefore, two ways in which the process of decay may be arrested, and further decay prevented, (a) by introducing throughout the timber a permanent germicide; (b) by destroying with heat, sufficiently prolonged, those germs already in the timber, coagulating thoroughly the albuminous constituents of the sap, and immediately sealing or inclosing the timber with a protective coat through which fresh germs of decay cannot penetrate. We may, therefore, divide timber preservation, as now practiced, into two general methods.

First.—Saturating the timber with an antiseptic solution.

Second.—Sterilizing and desiccating the timber by heat and sealing it with a preservative and protective coat.

During the past fifty years four principal methods of treatment have assumed commercial importance. Three of these belong to the former of the above classes, and one to the latter. They are:

(a) Impregnation with sulphate of copper, known as Boucherizing.

(a) Impregnation with sulphate of copper, known as Kyanizing.

(c) Impregnation with chloride of zinc, known as Burnettizing.

(d) Creosoting.

Under these general heads there are many varieties of treatment, but the first two, either from failures, expense, poisonous nature of the substance used, or other causes, are gradually falling into disuse. So that there remain now in the field practically only the last two.

Burnettizing.

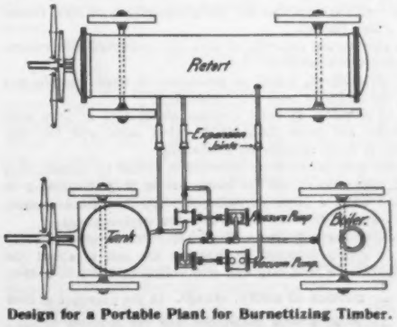
This process was proposed by Sir W. Burnett, in 1838. It has been in constant use in Hanover since 1849, and later has been adopted as a standard method throughout Germany and Austria. It was introduced into the United States in 1850, but has been extensively used only within the past twenty years. This process, so far, is principally in use for the treatment of railway ties, but there seems to be no reason why it should not be successfully used to prolong the life of timber for mining purposes.

The process of burnettizing is simple. The timber is dried by steam and the antiseptic solution then forced in. The theory of the use of chloride of zinc is that this substance is both an antiseptic and a powerful coagulent of albumen.

It is not considered necessary to thoroughly impregnate the timber throughout, during the process of treatment, with the zinc chloride solution, as the salt diffuses itself after treatment, provided a solution of sufficient strength be first used. Too strong a solution is to be avoided, because the zinc combines with constituents of sap, liberating hydrochloric acid, which, if too strong, injures the wood fiber. Practice limits the strength of the solution to a minimum of 1.5% and a maximum of 2.0%. If less than the minimum, it may not be long effective. If more than the maximum the fiber may be injured.

Chloride of zinc is cheaply and easily made by simply immersing zinc in muriatic acid until the acid is saturated, leaving no free acid to attack the piping, etc. This salt is now largely manufactured both in the eastern states and on this coast. Its cost in San Francisco is now about 4½ cts. per lb. in large quantities.

The apparatus for treatment is simple. It consists of one or more retorts, a boiler, a vacuum pump, a pressure pump, one or more storage tanks, and suitable piping. For short timber a plant could easily be arranged to be hauled around on wheels like an ordinary wagon, as shown in the accompanying cut. The cost is estimated



Design for a Portable Plant for Burnettizing Timber.

at $3,000. If steam is otherwise available, the boiler can be omitted. With such a plant having a retort, say, 3½ to 4 ft. diameter, and 16 ft. long, very effective work could be done in preserving timber to be used in mines.

The process in detail, consists in placing the timber to be treated in a closed retort, introducing live steam at 30 lbs. pressuure, allowing the mixed sap and condensed

*Chemist for and in charge of timber-preserving plants of the Southern Pacific Co. (Pacific system). Reprinted from the Thirteenth Report of the State Mineralogist of California.

water to drain off during the steaming, until the liquid shows little or no resinous constituents. Vents are then opened, and the steam blown off. A vacuum is then produced by a vacuum pump. This is continued until a condenser shows condensation at a rate per hour equal to ½ lb. of water per cu. ft. of timber. The retort is then filled with hot chloride solution, and the required quantity of solution forced into the timber by a pressure pump. The entire process, with large retorts holding 18,000 ft. B. M. of timber, usually requires a little less than seven hours.

Chloride of zinc alone is not usually regarded as a permanent preservative of timber, but the time to which its use prolongs the life of timber is not definitely known. It is certain, however, that it effects considerable ultimate economy in the cost of timbering.

It is often asserted that, owing to the extreme solubility of zinc chloride, it will soon leach out of timber exposed to rain or to much moisture. The author thinks that this objection is greatly exaggerated. He has attempted to leach this chloride out of timber with running water, but could extract only an insignificant portion, even when the timber was in fine shavings. All the chloride could not be taken out of chips from treated timber by boiling in repeated changes of water. If leaching takes place, it is certainly very slowly. This process hardens timber considerably. It allows the use of sap and other second quality timber, and in some cases the saving in cost, in this respect, more than offsets the expence of treatment.

Protection Against Fire.—This process renders timber much less combustible, and is, therefore, valuable as a fire preventive. All soluble chlorides have a great affinity for moisture. They will cause any substances, impregnated with them, to remain moist, and, therefore, much less inflammable than if treated. Common salt (sodium chloride) has long been known as a fire preventive for timber. In a paper by Mr. Robert Martin, and as in the discussion following (see Trans. Mining Inst. of Scotland, Parts 3 and 4, February and April, 1896), will be found an interesting account of the use of a mixture of sodium and magnesium chlorides for the fire protection of mining timbers. In this paper the remark is made that the "salted timber is easily distinguished from other timber by its damp appearance."

The Societe d'Encouragement de Paris about ten years ago awarded a prize of $400 for a fire-proofing solution to be applied to theatrical scenery, woodwork, etc. The principle effective ingredient of this solution was sal ammoniac (ammonium chloride).

Zinc chloride is extremely hygroscopic, much more so than either salt or sal ammoniac. Its affinity for moisture is such that it will keep timber damp in the driest climate. Timber containing an amount of this chloride sufficient for its preservation cannot be ignited until after the long application of a high temperature. The following experiments have been recently made on the combustibility of burnettized timber: Two boards, each 1 × 6 ins. and 2 ft. long, as nearly alike as possible, except that one was burnettized and the other untreated, were placed side by side closely under the grates in the ashpit of a boiler. At the end of 40 minutes the untreated stick was entirely consumed; the treated stick was charred ¼-in. deep. Two pieces of burnettized timber, one pine, the other red fir, each 4 ins. square, and two pieces of the same timber, same size but untreated, were placed on a hot blazing fire simultaneously. The untreated pieces blazed up at once and were consumed; the burnettized pieces smouldered an hour before they could be ignited. All these pieces were dried as far as possible before the experiment.

The net cost of burnettizing at San Francisco in large quantities is about $3 per 1,000 ft. B.M., for treatment.

Burnettizing is largely used by the Southern Pacific Co., the Atchison, Topeka & Santa Fe Ry. Co., and many other large railway systems for the preservation of ties, tunnel and other timber.

In purchasing chloride of zinc the following are recommended specifications:

If crystallized, fused or granular, it must contain not less than 97% of pure zinc chloride.

If in solution, it must contain about 45% of pure zinc chloride, not more than 2% of other salts, and the rest water; it must contain no free acids.

If the zinc chloride as received is found to contain free acid, slab zinc should be immersed in it and allowed to remain until a piece of polished zinc, free from grease, shows no action after immersion for twelve hours.

The presence of free acid of any kind in zinc chloride may be easily detected by diluting the salt to about the strength to be used, say 2%, and adding to 100 c.c., a drop of a $\frac{1}{1000}$ solution of methyl orange. In the presence of free acid this gives a pink indication, but the chloride is neutral to the indicator.

The strong solution of zinc chloride as furnished by the manufacturer is known as "stock solution of zinc chloride." It contains about 45% of zinc chloride and more or less of chlorides of other bases, some sulphate of zinc, and some oxide of zinc. The solid chloride of zinc is sold under various names, such as "fused" and "granular." It is the same stock solution evaporated down and melted. It is then broken up and packed in thin iron drums for shipment. It usually contains the same impurities as the stock. After dilution for use the solution is called "standard solution."

Creosoting.

This process consists in injecting hot creosote, or dead oil of coal tar, into timber with pressure, the timber having been previously dried by appropriate methods.

This process was invented by John Bethell, in England, about the year 1838. It was introduced into the United States in 1854. Its use has constantly increased since, and it is now an important industry. In the eastern states there are many large plants for the treatment of timber with creosote. Among these the most extensive and best known are: That of the Lehigh Valley R. R., at Perth Amboy, N. J.; of Eppinger & Russell, at Long Island City, N. Y.; of the Atchison, Topeka & Santa Fe Ry., at Las Vegas, N. M. On this coast the Southern Pacific Co. has two plants in which this process is worked.

An essential condition for success with this process is a suitable creosote properly applied. In the manufacture of ordinary illuminating gas, by the destructive distillation of bituminous coal, the following are produced: Illuminating gas, ammoniacal liquor, coke and coal tar. Of these the last is further distilled into naphthas, pitch and heavy or dead oils. This last is the creosote (so called) used in timber preservation. It is unfortunate that this substance should be known commercially as creocote, since it really contains only a very minute percentage of true creosote, such as is used in dentistry. The name creosote seems to have been given it from its similarity in smell to true creosote. As, however, it is universally known by this name, it will be so called in the rest of this article.

The principal necessary ingredients of a good creosote for timber preservation are: About 8% of tar acids or phenols-carbolic and cresylic acids; about 20% of naphthalene; about 30% of heavy residuum after distillation up to 600° F., consisting principally of anthracene and pitch. The remainder, light and heavy oils, principally of use as solvents for the necessary ingredients.

Creosote should contain no ammonia or water. It should be completely liquid at 100° F., in order to enable it to be easily handled by pumping, and in cooling should show little or no deposit above 90° F. It should contain no ingredients soluble in water.

At one time much stress was laid upon the toxic effect of certain alkaloids present in coal tar creosote; these are acridine and cryptidine, but their beneficial effect has not been demonstrated.

It appears to be a fact that only a creosote constituted as above will insure satisfactory results, and as these qualities, in such combination, are found only in the dead oil of coal tar, it is customary to specify that the creosote must be the product of bituminous coal tar only. This excludes creosote made from wood tar or from petroleum tar.

The timber to be treated is first dried (or rather, has the moisture driven out of the cells.— Ed.) in retorts by steam applied either directly or to a bath of creosote in which the timber is immersed. When thoroughly dried, creosote is injected by pressure.

During this process the timber is first thoroughly sterilized and desiccated by heat, and immediately afterward sealed externally by creosote. All albuminous ingredients of the sap are coagulated by heat and the liquid or volatile tar acids and naphthalene. All germs are destroyed, and an external protection afforded through which fresh germs cannot penetrate. The superficial coat of heavier material affords efficient protection against external attack by the teredo, limnoria, etc.

During injection a mechanical separation of the creosote takes place to some extent. The lighter and more fluid tar acids and naphthalene penetrate farthest, while the heavier portions, mostly the residuum above referred to, remain near the surface by filtration. Good practice requires that there should be sufficient "black" penetration to prevent its being torn away, in the ordinary handling and shipment necessary, by timber hooks, etc. For piles this requires not less than 10 lbs. of creosote per cu. ft. of timber, and for smaller timber proportionately more, so as to give the same superficial penetration. For important work it is better to allow 14 lbs. per cu. ft. to insure success. But so long as there is a sufficient external coat to insure protection to the interior there seems to be no object in applying more.

The increased demand for the heavier portions of creosote in the manufacture of artificial madder and for roofing pitch renders it difficult to obtain cheaply creosote having a sufficiency of residuum. This has led the author to make some experiments on mixing with a lighter creosote, a proper portion of asphalt, so as to supply the necessary heavy constituents. The asphalt used for this purpose should be nearly solid at ordinary temperature, but not hard or brittle. When such asphalt and creosote are heated and stirred together, an intimate mixture results. This does not separate on cooling, and the resulting compound acts, as far as yet ascertained, in all respects as ordinary creosote, except that it is more fluid than either the original creosote or the original asphalt at the same temperature. Apparently a chemical combination of some kind takes place, changing somewhat the physical properties of the original ingredients. But our experience with this mixture is not yet sufficiently extended to warrant its recommendation for general use.

The net cost of creosoting in San Francisco with a properly designed plant, and at current rates for labor and material, for injecting 10 lbs. of creosote per cu. ft. is about $20 per 1,000 ft. B. M. The creosote costs about 13 cts. per gallon in San Francisco. It is manufactured on a large scale in the eastern states, in England and to some extent on this coast.

It is not to be supposed that any mode of timber preservation now known will, under all circumstances, prolong the life of timber indefinitely. It may be relied upon that burnettizing will extend the life of timber to at least double that which it would have if untreated, and that creosoting properly done will preserve timber, under the most unfavorable circumstances, for at least 25 years. These conclusions are the results of a great many observations and records.

In the matter of wood preservation the following axioms may be regarded as well established:

No process can be considered as generally effective which affords superficial protection only; such treatment may defend timber against external attack, but it provides no protection against internal decay.

Unless preservative treatment is well done, using proper materials, it is a waste of time and money. As a corollary to this, no material should be used for wood preservation until its suitability has been determined by analysis, and no finished product accepted until after thorough inspection.

A SMALL WATER FILTER BED AT CANTON, PA.

By James P. Herdic.

The water-works of Canton, Pa., were built in 1880 by Mr. Peter Herdic, of Williamsport, Pa., and are now operated by the writer, as lessee. The main supply is from a mountain stream, the water being of fine quality and sufficient for the needs of the town, except in very dry seasons. When it is necessary to supplement this source, water is drawn from Lake Nepahwin, in the hills at the opposite side of the town. The lake has clean, steep banks, and is fed from

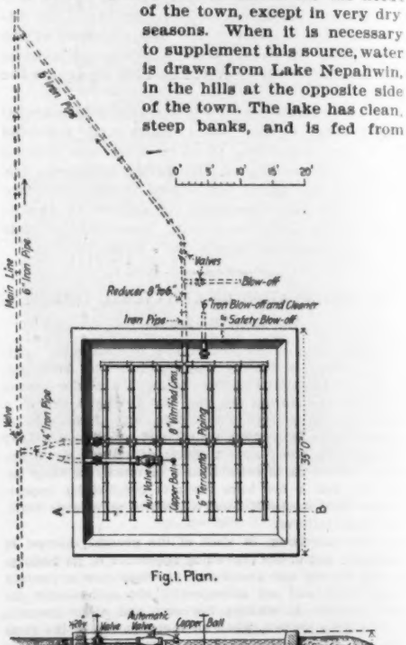


Fig. 1. Plan.

Fig. 2. Section A-B.

Figs. 1 and 2.—Plan and Section of Filter Bed at Canton, Pa. Jas. P. Herdic, Williamsport, Pa., Engineer and Builder.

springs at the bottom. The water has a slightly dark green color and in the hottest summer months gives off a slight odor. A gravity filter has been constructed to remove the color and odor.

The filter bed is located on the 6-in. supply main, 1½ miles from and 50 ft. below the lake, where the main begins a rapid descent of about 275 ft. in about 5,000 on its way to the town.

The general character and dimensions of the filter are shown by the plan, Fig. 1, and the section, Fig. 2. The area of the bed is 1,225 sq. ft., and the filtering material, as shown, is 4 ft. deep, including the loose stone at the bottom. The tile drains have flat stones laid over them, resting at

each side on the broken stone, this being designed to prevent the crushing of the pipes by the sand and gravel above.

Water is admitted at the top of the filter, an automatic float valve regulating the supply. The flow can be reversed for washing by shutting off the regular supply and opening the valve in the lower feed pipe and in the upper blow-off pipe. The water may also be drained out of the filter by shutting off the supply to the town and opening the gate in the blow-off branch leading from the supply main.

The filter was designed and built by the writer. The originals from which the illustrations were prepared were drawn by Mr. Frank Hinckley, of Williamsport. The population of Canton in 1890 was 1,393.

AN IMPROVED MOMENT TABLE.

By W. C. Armstrong, C. E.*

The accompanying table for computing moments and shears in bridge trusses from concentrated loads presents some new features which it is believed reduce the arithmetical work to the least possible limit consistent with the desired accuracy. These features, which are additional to the form of table in general use, are: (1) The load line; (2) the scale; (3) the table of total moments.

The load line is the stepped line running diagonally from the lower left hand to the upper right hand corner. It is used in determining the positions of the load giving maximum moments and shears at different points of the truss. It is not claimed that the load line is, in itself, a new feature; but it has never before been, to the writer's knowledge, embodied in any form of the moment table. It was fully explained by Mr. Ward Baldwin, M. Am. Soc. C. E., in Engineering News of Sept. 28, 1889; and is also very completely discussed in Prof. Johnson's "Theory and Practice of Modern Framed Structures."

The scale, shown at the bottom of the sheet, is one of the important features of this table. Its purpose is to eliminate the error due to the shrinkage of blue-print paper,—as blue-print copies of the table are generally used in practice.

The table of total moments is the most essential labor-saving feature. It is that portion lying below and to the right of the load line; and consists of the tabulation of the sum of the moments in thousands of foot pounds of all the loads to the left about a point beginning under wheel 9 and advancing by intervals of one foot to a point 99 ft. from the end of the uniform train load. This tabulation can be carried to any desired extent. The last quantity in the table (54,281) is the moment of all the loads about a point 208 ft. to the right of wheel 1; and is probably carried far enough to accommodate a large majority of the cases in actual practice. Spans which exceed this limit can be calculated in the usual way from the general moment table, which is that portion lying above and to the left of the load line.

*Draftsman of the Toledo Bridge Co., Toledo, O.

To explain the method of using the table we will assume a truss 154 ft. long divided into 7 panels of 22 ft. each. It is required to find the maximum moment at each panel point and the maximum shear in each panel. Take a strip of paper long enough to lay out the span to a scale of 8 ft. to one inch. Cut one edge of the paper to a straight line. Place the strip upon the table with the straight edge just below the scale, and mark off each panel point of the truss, using the subdivided 10 ft. of the scale at the right for greater accuracy. Then mark each foot of the first 10 ft. to the left of the right abutment just the same as the scale.

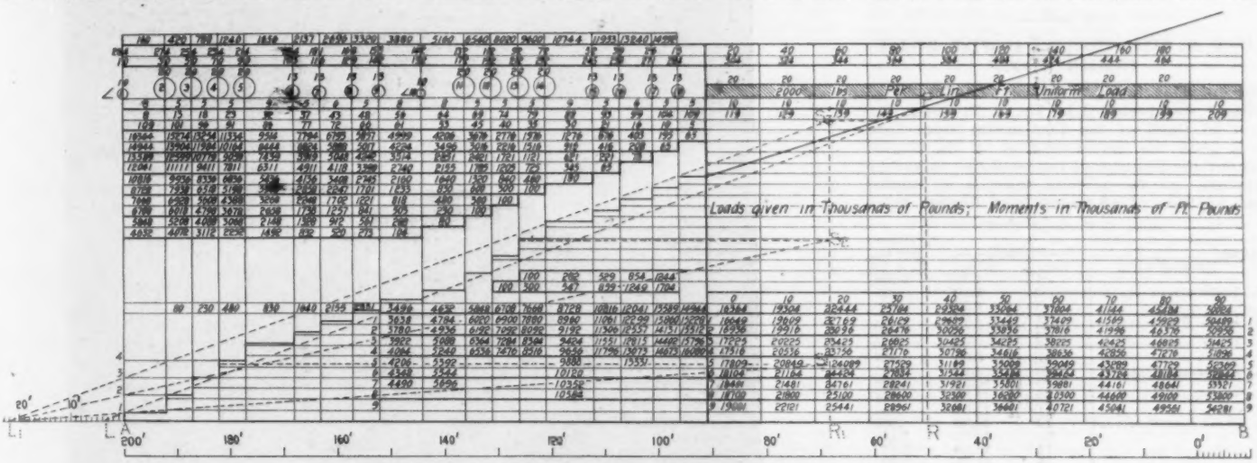
We will now describe, briefly as possible, the method of determining the positions of the load giving maximum moments and shears at different points of the span; referring the reader to Prof. Johnson's "Theory and Practice," or to the article in Engineering News mentioned above, for a more complete discussion.

Place the strip of paper just below the base line AB, with the first panel point from the left under wheel 4, which is assumed to be the position for maximum moment at this point. The span then extends from L to R. Draw a line from L to P, where a vertical through R intersects the load line. This line cuts the vertical part of the load line under wheel 4, which indicates that the load is in the proper position for maximum moment at the first panel point. Had the line LP passed ABOVE this vertical part of the load line, then maximum moment would have been produced when some wheel to the right of wheel 4 stood over this panel point; and had it passed BELOW this vertical portion, then maximum moment would have been produced when some wheel to the left of wheel 4 stood over this point. This is the criterion for maximum moment.

Now to find the positions of the load giving maximum shears, place the strip of paper on the table with the first panel point from the left under wheel 1. The span then extends from L_0 to R_1. Then from L_1, through the points 1, 2 and 3, above A, representing wheel loads 1, 2 and 3 respectively, draw the lines L_1S_1, L_12S_2 and L_13S_3, intersecting a vertical through R_1 at S_1, S_2 and S_3. From these points of intersection project horizontal lines to intersect the load line. The horizontal through S_1 cuts the vertical part of the load line under wheel 4; the horizontal through S_2 cuts the vertical part of the load line under wheel 13; and the horizontal through S_3 cuts the load line at a point 33 ft. from the end of the uniform train load. This indicates that as the train comes on to the bridge from the right, wheel 1, upon reaching a panel point, produces maximum shear in the panel just ahead until wheel 4 comes upon the bridge; after which wheel 2, upon reaching a panel point, produces maximum shear in the panel ahead until wheel 13 comes upon the bridge; after this wheel 3, upon reaching a panel point, produces maximum shear in the panel ahead until 33 ft. of uniform train load comes upon the bridge; then wheel 4, upon reaching each succeeding panel point, produces maximum shear in the panel ahead. This is the criterion for maximum shear.

The dotted lines and letters indicating points on the table are only for the purpose of illustrating this article and do not form a part of the table used in practice. No lines need be drawn. The straight edge of the strip of paper will serve the purpose of lines and give all that is required without mutilating the table.

We found above that maximum moment was produced at the first panel point from the left when wheel 4 stood over this point. In the same way it may be found that maximum moment is produced at the second panel point when wheel 6 stands over this point; and at the third panel point when wheel 11 stands over it. We also find, from the conditions for shear in this particular case stated above, that maximum shear occurs as follows: In the first panel at the left when wheel 4 stands over the first panel point; in the second and third panels when wheel 3 stands over the second and third panel points respectively; and in the fourth and fifth panels when wheel 2 stands over the fourth and fifth panel points respectively.



AN IMPROVED MOMENT TABLE FOR COMPUTING BRIDGE STRESSES.
Designed by W. C. Armstrong, C. E.

Having found the positions of the load giving all the maximum moments and shears, we proceed to find the amount of the same. Place the strip of paper on the table with the first panel point from the left under wheel 4,—the position for maximum moment at this panel point. The right abutment then comes to a point 41 ft. from the end of the uniform train load. We then read directly from the Table of Total Moments, in the column headed "40," and in the line indicated by the marginal figure 1, the moment of all the loads about the right abutment (29,689,000). The moment of all the loads to the left about wheel 4 (480,000) is also read directly from the table. Then we have for the moment at the first panel point,

$$\frac{29,689,000}{7} - 480,000 = 3,761,300 \text{ ft. lbs.}$$

Shifting the strip of paper so that the second panel point is under wheel 6,—the position for maximum moment at this point, we read the moment of all the loads about the right abutment (26,825,000), and the moment of all the loads to the left about wheel 6 (1,640,000). Hence the moment at the second panel point is

$$\frac{26,825,000 \times 2}{7} - 1,640,000 = 6,024,300 \text{ ft. lbs.}$$

In the same way with wheel 11 over the third panel point we find the moment to be

$$\frac{30,425,000 \times 3}{7} - 5,848,000 = 7,191,300 \text{ ft. lbs.}$$

Now, for maximum shear in the first panel, we place the first panel point under wheel 4. Since this is the same position as for maximum moment

at the first panel point, we have the same moment about the right abutment (29,689,000), and the same moment for all the loads to the left about wheel 4 (480,000). Hence the shear is

$$\frac{29,689,000}{154} - \frac{480,000}{22} = 171,000 \text{ lbs.}$$

In the same manner, by placing wheel 3 over the second and third panel points and wheel 2 over the fourth and fifth panel points respectively, we find the maximum shears in the other panels as follows:

$$\text{Second panel, } \frac{20,536,000}{154} - \frac{230,000}{22} = 122,900 \text{ lbs.}$$

$$\text{Third panel, } \frac{14,131,000}{154} - \frac{230,000}{22} = 81,300 \text{ lbs.}$$

$$\text{Fourth panel, } \frac{7,668,000}{154} - \frac{80,000}{22} = 46,200 \text{ lbs.}$$

$$\text{Fifth panel, } \frac{4,064,000}{154} - \frac{80,000}{22} = 22,800 \text{ lbs.}$$

It does not seem possible to devise simpler methods for calculating stresses from concentrated loads. At any rate, the writer believes that the additions to the moment table herein described will to some considerable extent satisfy the demand for less laborious methods of calculation.

TABLE OF WIND PRESSURES ADOPTED BY THE ENGLISH NAVY.

The following table, taken from London "Engineering," was prepared by Mr. J. T. Conor, Engineer in Chief of the Portsmouth Dock-Yard, and it gives the figures adopted by the English Navy for the pressure of the wind due to various velocities. As the velocity table is in English knots, we have added a column of English miles.

Table of Force of Wind.

Nautical No.	Name of wind.	Velocity—Knots.	Velocity—Miles.	Force per sq. ft. in lbs.
1.	Light air	1	1.15	0.0067
		2	2.30	.027
		3	3.45	.060
2.	Light wind	4	4.60	.107
		5	5.75	.167
3.	Light breeze	6	6.90	.240
		7	8.05	.327
4.	Moderate breeze	8	9.20	.427
		9	10.35	.540
		10	11.50	.667
		11	12.65	.807
5.	Fresh breeze	12	13.80	.960
		13	14.95	1.13
		14	16.10	1.31
		15	17.25	1.50
		16	18.40	1.71
6.	Strong breeze	17	19.55	1.93
		18	20.70	2.16
		19	21.85	2.41
		20	23.00	2.67
7.	Moderate gale	22	25.30	3.23
		24	27.60	3.84
		26	29.90	4.51
8.	Fresh gale	28	32.20	5.23
		30	34.50	6.00
		32	36.80	6.83
9.	Strong gale	34	39.10	7.71
		36	41.10	8.64
10.	Heavy gale	38	43.70	9.63
		40	46.00	10.7
11.	Storm	45	51.75	13.5
		50	57.50	16.7
		60	69.00	24.0
		70	80.50	32.7
12.	Hurricane	80	92.00	42.7
		90	103.50	54.0
		100	115.00	66.7

This table seems to be based on the old one first published by Smeaton in 1759. It is far from being correct as expressing the relation between the velocity and the force of wind, as was shown in our issues of July 5, 1890, and Feb. 9, 1893. Smeaton's table corresponds to the formula $P = 0.005\ V^2$, in which P is the pressure per square foot, and V the velocity in miles per hour. Modern experiments have shown that the coefficient 0.005 is probably much too high, the results obtained generally varying between 0.003 and 0.005, and as low as 0.0014 has been obtained.

REPORT OF THE PASSAIC VALLEY SEWERAGE COMMISSION.

A dry summer in 1895, with attendant low water in the Passaic River, directed attention in an irresistible manner to the gross pollution of the stream by the sewage of a number of rapidly growing cities. The local communities affected, largely through their Boards of Health and in co-operation with the State Board of Health, met in convention, discussed the situation and took action which finally resulted in a thorough investigation of the pollution of the Passaic River and the means by which it may be obviated.

Acting under a legislative statute, Gov. Griggs, of New Jersey, in April, 1896, appointed as an investigating commission, Messrs. Wm. T. Hunt, of the Newark "Call;" Herman C. H. Herold, M. D., President of the Newark Board of Health, and Elias J Marsh, M. D., of Paterson. The commission engaged Mr. Alphonse Fteley, M. Am. Soc. C. E., of New York city, as Consulting Engineer, and Chas. E. A. Jacobson, of Newark, as Resident Engineer. The latter died Feb. 10, 1897, soon after completing his report.

The commission found the upper Passaic River, or that portion above Paterson, in a very fair condition, but in need of conservation in the future. The Lower Passaic, from the Great Falls at Paterson to Newark Bay, is grossly polluted, receiving already some 70,000,000 gallons of sewage per day from Paterson, Passaic, Orange, Newark, East Orange, Bloomfield, Montclair, Harrison, Kearney, East Newark and part of Rutherford. As a remedy, a trunk sewer is proposed to extend from Paterson to a pumping station near Newark Bay, a distance of 23.64 miles, with an intermediate pumping station just above the northerly city limits of Newark. The outfall from the lower station to the bay would be 1.9 miles long, making a total length of 25.54 miles. The sewer would be equivalent in size to a 3-ft. circular brick conduit at its upper end, and a 10-ft. at its mouth, the fall being 2½ ft. per mile, except for two short stretches near the Paterson and Passaic Falls, where the grade would be 3.77 and 1.88 ft. per 1,000, or 19.9 and 9.93 ft. per mile, respectively. The three branch sewers contemplated aggregate 9.02 miles in length.

The area to be provided for, not all of which is now provided with sewers, had a population of 246,503 in 1880, 353,043 in 1890 and 436,423, by the state census of 1895. The works are designed to serve the communities until 1930, when it is estimated that the population will be 1,458,000. Provision is made only for sewage proper, although the greater part of the existing sewers in the territory covered are on the combined plan. An allowance of 150 gallons of sewage per capita is made, which would give 75,000,000 gallons in 1900 and 218,700,000 in 1930.

The estimated cost of works for the disposal of 220,000,000 gallons per day is $6,500,000, including land. This is for the discharge of crude sewage into tide water, with a lift of 16 ft. at the intermediate and of 21 ft. at the main pumping station. None of the sewage of Newark, Orange and several smaller communities, aggregating 275,000 of the 435,000 population in 1895, would be pumped at the upper station, but all of it would be lifted at the lower one.

The yearly operating expenses are estimated at $125,000 in 1900 and $300,000 in 1930. Increase tidal chambers should become necessary later on, their estimated cost of construction is $650,000 in 1915 and $1,350,000 in 1930. If this method of disposal should become inadequate, an extension across Staten Island to the outer New York Harbor is recommended. The dilution of sewage at the proposed outlet is estimated at 300 times in 1900 and 100 times in 1930; the volume of water in the bay displaced by each tide being placed at 12,500,000,000 gallons.

The purification of the sewage both at isolated stations and at a central station is discussed; but tide water disposal is considered by the engineers and commissioners as far more desirable.

The commission recommends the passage of a general act authorizing the governor to appoint, at his discretion, Pollution Commissioners for any stream in the state, whenever duly authorized commissioners shall have reported the pollution of such stream a nuisance or a menace to health. The commissioners would have power to make and enforce rules against the further pollution of the stream under its charge, and to construct intercepting sewers and disposal works, including purification plants, to remedy existing pollution. The expenses incurred by the commission would be borne by the communities benefited. The act is made general because special legislation is prohibited by the constitution of New Jersey, but in framing it the Passaic commission doubtless had in mind the needs of other stream valleys of the state. To be of the greatest use to other sections the act needs either amendment or a supplementary act, as is shown in our editorial columns. The appropriation at the disposal of this commission was $10,000 and it kept within that limit.

MASONRY ARCH AT ENTRANCE TO THE CAMPUS OF CORNELL UNIVERSITY.
H. N. Ogden, Engineer.

BRICK ARCH WITH STONE FACING AT THE ENTRANCE TO CORNELL UNIVERSITY CAMPUS.

During the past summer improvements on a large scale have been made at the entrance to the Cornell University campus. These changes have included the removal of a bank of 8,000 cu. yds. of sand and gravel, the building of a retaining wall 30 ft. high, and in other ways smoothing and extending the approaches to this incomparably picturesque campus. Besides the other work mentioned, there has been built in place of an old cast iron bridge, a brick arch, spanning a deep ravine which separates the University grounds from the city proper. The design and direction of the work was placed in charge of Mr. H. N. Ogden, an instructor in the College of Civil Engineering.

The arch, a view of which is given, has a clear span of 63 ft., a rise of 18 ft., a thickness of

arch ring of 30 ins., and a width over all of 33 ft. The thickness of the arch ring is less than is called for by Trautwine's rule, and is the same thickness as in the Filbert St. arches under the Pennsylvania R. R., in Philadelphia (50 ft. span and 7 ft. rise). The foundations on each side are carried down to the solid rock, on the south side 4 ft. lower than on the north, and there is a grade in the string courses of 2 ft. in the length of the bridge. The shale was soft enough to be readily cut or chiselled into the steps required for the foundation and the masonry backing, this last proportioned by Trautwine's rule. The extrados of the brick arch and the top of the backing were well plastered with a cement coat and then with a half-inch layer of Sicilian asphalt, of which two barrels were used.

The falsework was designed and built by the contractors of 2×6-in. plank, spiked or bolted together into 4×6-in. timbers, spaced 6 ft. apart in both directions. These struts, the longest 60 ft. in length, were built up from the bottom of the gorge, braced and tied to each other and to the rock for rigidity. The upper ends were capped by 4×6-in. pieces, running parallel to the axis of the arch, and directly under the arch ribs, which were supported on wedges at each strut. The arch ribs were of 2×12-in. plank spliced together at the ends, the curve being made in separate pieces, spiked on the edge. The ribs were spaced 18 ins., c. to c., resting on the tops of the struts and were cut into enough to get a bearing on the sill piece. The lagging was 1-in. hemlock boards. The wedges were 2-in. wide, of pine, and tapered 1 on 10 in the 15-ins. of their length, and a pair were placed at the top of every strut. They served their purpose admirably, and no difficulty was experienced in driving or tightening them as was found necessary.

In the construction, the arch was built from both sides as far up as the haunches, and then, the wedges above loosening a little, a load of about 8,000 brick was placed on the crown of the falsework. A true center for the outside of the lagging had been found, and the curvature was continually tested with a tape fixed at the center, and any deviation from the true circular arc was immediately corrected. After the crown had been loaded, it was thought best to carry the arch ring across in partial thickness, and an 8-in. ring was carried up from both sides and joined. No further deviation was noticed, and when, three months afterwards, the centers were struck, beginning at the bottom on each side, no settlement was perceptible, though the arch was followed at three points, carefully, with an engineer's level. The bond was the ordinary English bond with headers every five courses tying together the separate rings. The difference in length of two rings was so little that no trouble was found, and by toothing across at different points, so that no header course went entirely through the arch ring at one place. A bond was obtained without using special brick or having recourse to any special devices. The arch ring was faced with limestone from the vicinity alternately setting 20 and 30 ins. into the brick ring. The spandrel walls, also of limstone, were 4 ft. thick at the springing line and 2 ft. thick at the crown, in both cases carried up straight to the road surface, 5 ft. above the ring. Strap iron, 2×½×5 ins. was set into the spandrel walls, every 3 ft., and carried back into the brickwork to bind the different kinds of masonry together. The contractors estimate that about 30,000 ft. of lumber were used in the falsework, and that there were about 103,000 brick in the ring. The brick were hard burned building brick, samples tested averaging over 5,000 lbs. per square inch before crushing. The contract price for the work was $6,260, including, besides the arch proper, a macadam roadway and a cement sidewalk, 8 ft. wide, as well as the removal of the old bridge and all clearing and digging. Other bids received for the same work, including one for a concrete arch, ranged from $8,000 to $15,000, the difference in cost apparently lying in the use of a different stone, and in larger unit prices for the class of work furnished.

The rough stone work used is in admirable keeping with the natural beauty of the gorge, and the whole improvement in its detail and good taste is due to the care and generosity of W. H. Sage, the Chairman of the Committee on Grounds.

THE SUBMARINE CABLE between New York and Hayti, opened to business last December by the Commercial Cable Co., is about 1,500 miles long. The cable rate from New York to Hayti is $1.50 per word, and for $1.70 per word Venezuela may be reached. From Hayti there is direct cable connection with the island of Martinique and Parramaribo, Cayenne and Para on the South American coast, and all the smaller islands forming the eastern boundary of the Carribean Sea are linked together and with Demerara by cable. Another cable goes from Hayti to Curacao and to Caracas, in Venezuela; but to reach Jamaica and Colon the line passes first from Hayti to Cuba.

THE TELEGRAPH BUSINESS OF THE WESTERN Union Telegraph Company, says the "U. S. Statistical Abstract" for 1896, has increased as follows in the last 30 years:

	1866.	1876.	1886.	1896.
Miles of line	37,380	73,532	151,832	180,918
Miles of wire	75,686	183,832	489,607	826,929
No. of offices	2,250	7,072	15,142	21,725
Mess'gs sent	..	18,729,567	43,289,807	58,760,442
Receipts ...	..	$10,034,983	$16,298,638	$22,612,736
Expenses ...	..	6,635,473	12,378,783	16,714,756
Average toll per mess.	..	50.9 cts.	31.3 cts.	30.9 cts.
Average cost per mess.	..	33.5 cts.	23.4 cts.	24 cts.

The sudden increased mileage after 1880 was principally due to the fact that in 1881 the Western Union Telegraph Company absorbed by purchase the lines of the American Union and the Atlantic & Pacific companies, with an aggregate of nearly 21,000 miles of line. The capital stock of the Western Union Telegraph Company is $100,000,000. The New York Mutual Telegraph Company, established in 1881, has about 8,000 miles of line, 60,000 miles of wire and 1,200 offices, with a capital stock of $2,500,000. This line is now leased and operated by the Western Union Company at a rental of 6% on the stock. There are some other, but minor operating telepraph companies.

THE CONCENTRATION OF NEW JERSEY IRON ores at the works of Mr. Thos. A. Edison, at Ogden Mine, N. J., according to a statement made by Mr. E. Gybbon Spilsbury in his recent address as retiring president of the American Institute of American Mining Engineers, is a remarkable success from a mechanical point of view, but its commercial success is rendered doubiful for the present by the very low price of other ores which require no concentration. We quote the following extract from Mr. Spilsbury's address

I cannot well leave the subject without calling to your attention the remarkable work in mining, crushing, concentrating and finally briquetting of magnetic iron ore which is being carried on at the Ogden mine in New Jersey by Thomas Edison. As a theoretical development and improvement of the very highest type these works of his stand out unique, but it has not yet been demonstrated in regular practice that the enormous outlay such a complete plant calls for (the present plant at Edison being reported as involving already an expenditure of $1,500,000) would be warranted except in very exceptional cases. The experiments so far carried out on some 30,000 tons of rock have demonstrated the fact that an ore averaging not over 30% iron can be quarried or mined, transported by rail ¼ mile to the mill, there crushed, sized and recrushed to a fine powder, the magnetic iron separated from the non-magnetic gangue, the concentrates mixed with a binder, then pressed into briquettes, furnace dried and loaded on cars for less than 6 cts. per unit of the iron contents of the briquettes. Even under the present conditions of low prices, if resulting concentrates were low enough in phosphorus to bring them within the Bessemer limits the operation could be carried on to financial success, but unfortunately such is not the case, and therefore until the price of foundry pig shall advance to a figure at which it will be profitable to purchase a 68% iron ore at 6 cts. a unit it is not probable that the Edison works can be run continuously at a profit. It stands, nevertheless, a monument of perseverance in original research which certainly deserves our admiration.

"THE MINERAL RESOURCES OF THE UNITED States for 1895," says Director Charles D. Walcott, of the U. S. Geological Survey, must be obtained from Congressmen, who have a limited number for distribution. This is in accordance with an act of Congress of March 2, 1895, providing that "hereafter the mineral resources of the United States shall be issued as a part of the report of the Director of the Geological Survey." Director Walcott has issued a card to this effect to answer the numerous enquiries for this valuable document.

THE COST AND LIFE OF PAVEMENTS in Wolverhampton, England, is made the subject of a late report by the Borough Engineer. Granite blocks with Portland cement concrete base, 6 ins. thick, cost $3 per sq. yd. and have a probable life of 30 years. Australian hard wood blocks, set on the same base, cost $4.50 per sq. yd. and have a life of 18 years, and creosoted deal blocks on the same base cost $3 per sq. yd. and have a life of 12 years. Natural rock asphalt pavement, 2 ins. thick, on a 6-in. Portland cement concrete base, can be laid for $3.24 per sq. yd., with a calculated life of 15 years. The total expenditures upon these pavements, for 30 years, for maintenance, cleaning and watering, is fixed as follows: Common area, 7,292 sq. yds.; granite, $45,000; Australian hard wood, $87,210; creosoted deal, $73,800; natural rock asphalt, $65,175.

A SAND BOX, for holding sand to be used for sprinkling steep grades on asphalt-paved streets when they become slippery in wet and frosty weather, has been designed by Mr. E. P. North, M. Am. Soc. C. E., Water Purveyor of New York city. It is of a plain but neat design, 50 in. high, 20 in. long and 10 in. wide, with a semi-cylinderical cover. It may be made of cast iron ¼ in. thick or steel ⅛ in. thick. The boxes are to be painted inside and out with one coat of red lead and two coats of dark green. Fifty of these boxes have been ordered.

IMPROVEMENTS TO THE RESERVOIR AND PIPE system of the Philadelphia water-works are recommended by a special committee of the select council of that city. The improvements proposed include more storage capacity; the connection of all reservoirs, so that those on the lower levels may be suplied by gravity from those above; an additional force main between the Queen Lane pumping station and reservoir, to make available two additional pumping engines; large mains on Broad and Market Sts. The total storage capacity of the reservoirs, as designed, is 1,418,000,000, but defects in the Fairmount, Queen Lane and New Roxborough reservoirs rendered only 1,143,000,000 galls. available Jan. 12, 1897, with repairs begun to make available the whole capacity. The storage was considerably less during the greater part of the year. Lack of storage is a serious matter, owing to the large amount of mud and coal dust carried at times. The maximum daily pumpage in 1896, as shown by plunger displacement, was 287,000,000 galls., or one-fourth the total storage capacity in January, 1897. Some sections of the city have virtually direct pumpage, the reservoir capacity being too small to afford sedimentation.

A SELF-PROPELLED, OR HORSELESS, STEAM fire-engine, of the Armstrong type is being built by the Manchester, N. H., Locomotive Works for the city of Boston. This engine is designed especially for fighting fires in tall office buildings. It is known as a "double extra first size self-propeller." Its dimensions are: Height 10 ft.; length over all, 16 ft. 6 ins.; width, 7 ft. 3 ins. The weight, equipped for service, is 17,000 lbs. The heaviest engine for three horses weighs 10,000 lbs. The new engine will be able to travel on a level street at a speed of 12 miles an hour, and to climb any ordinary grade.

THE DANGEROUS NATURE OF WATER-GAS, as compared with coal gas, which was a live question 15 or 20 years ago, when the gas companies in the large cities began to change their systems of manufacture from the old retort system to the Lowe water-gas system, is now under discussion in Boston, and majority and minority reports on the subject have been submitted to the legislature by the committeee on manufactures. It appears that the number of deaths in the city of Boston, resulting from the inhalation of gas, has greatly increased in recent years, the figures being as follows: 1893, 23; 1894, 26; 1895, 22; 1896, 43. The consumption of gas has increased over 43% in three years, notwithstanding the great increase in the use of electric light. The majority report says that this increase in gas consumption is due to the decrease in its price, consequent upon the reduction in cost made by the use of the water-gas process; that the increase is chiefly in the tenement house districts and among the poorer classes, and that the increase in the number of deaths is due to the increased use of gas, and that in almost every case the fatal result was due to suicide, drunkenness, carelessness or ignorance. The minority report says that the increase in the number of deaths is due to the substitution of water gas for coal gas; that it was a mistake in 1890 to allow the manufacture of water gas, which mistake it was easier then to make than it is now to remedy. The minority of the committee, believing that prohibition of the manufacture of water gas is now a practical impossibility, suggests the passage of an act to compel the operation of the existing coal gas plants in Boston, and the mixing of the coal gas with the water gas, so as to reduce the carbonic oxide in the mixture to below 16%, and to prohibit the distribution of gas containing a higher percentage of carbonic oxide. The minority also submits an order requiring the board of gas and electric light commissioners to furnish certain statistical information concerning the manufacture and distribution of coal and water gas, the number of accidents from each, and its opinion as to what feasible method or procedure may be expected to result in a diminution of the fatalities by gas in Boston.

THE BREAKING OF GLASS WATER GAGES is one of the troubles in the boiler room which has become more frequent with the use of higher steam pressure. The Manchester Steam Users' Association says in regard to them:

They should be fitted with guards, so as to protect the attendants in case the sages should burst when they are being tested, as too often attendants have been strdck in the eye and thereby their sight destroyed. These

guards should be made of toughened glass, and the glass plates should be tested by being laid horizontally on a couple of supports and having a wooden ball dropped upon them. Further, the edges should be perfectly smooth, as rough edges are apt to lead to fractures. It may be of service to the members to state that the Jena glass tube is found to give very satisfactory results, and those who have adopted these glasses speak very highly of them, the number of burst tubes being very materially reduced. One point adopted in the manufacture of these glasses as well as of some others, though very simple, is worthy of comment. The ends, instead of being cut and ground, which leaves the edges somewhat ragged, are melted and finished off smooth.

PACKING GOODS FOR EXPORT seems to be an art yet to be learned by American manufacturers. A late news item tells how two American makers of track supplies lost a prospective South American market by refusing to pack track-bolts and spikes so that they could be carried on mules. An English maker supplied the special packages demanded and secured a trade which has a prospect of growing.

CORTECINE is a new deck covering for warships lately adopted by the British Admiralty as a substitute for the 2 to 3½-in. layer of fir or teak formerly placed over the steel deck plates. This cortecine is not fully described, but it is a special composition usually laid on a thin layer of cement. Its advantages are lightness, less space occupied and less liability than wood to leak in hot climates.

CELLULOSE, BACKED AND FACED BY THIN steel plate, is suggested as a new kind of armor. The makers of cellulose claim that this material, besides its water tight qualities, has great resisting power against projectiles. Naval experts admit that it has some resistance, and also say that a shot "wobbles" in passing through it and may be stopped by thin armor. But a shell exploding in the cellulose would probably displace it entirely, spring the back-armor and admit water.

BIDS FOR 8,100 TONS OF ARMOR PLATE will be shortly called for by the Secretary of the Navy, at a maximum price of $300 per ton. This armor is for the three new battleships, and is to be of the same quality and subjected to the same tests as the armor for the "Kearsarge" and "Kentucky," which cost $572 per ton.

THE LARGEST SPECTROSCOPE in the world has just been completed by Mr. John A. Brashear, of Allegheny, Pa., the well-known astronomical instrument maker. It was made for the private research laboratory of Dr. Hans Hauswaldt, a wealthy scientist of Magdeburg, Germany. The instrument contains a concave diffraction grating with 110,000 lines per inch, made on the famous ruling machine of Prof. Henry A. Rowland, of the Johns Hopkins University.

A SURVEYING CAMERA, styled the Bridges-Lee instrument, is being introduced by Mr. J. Hicks, of Hatton Garden, London, England. It resembles an ordinary camera, having a brass-bound box with rapid rectilinear lens and double backs and the usual ground-glass screen. The camera body turns on a horizontal plate having a graduated rim, over which slides a vernier attached to the camera for reading horizontal angles. A clamping screw fixes the camera body to the bottom plate, which plate is mounted on a tripod-head provided with levelling screws. On top of the camera box is fixed a rotating level and a telescope mounted on a horizontal arm, and fitted with a rack adjustment and a scale permitting vertical angles to be taken. This telescope has a vertical wire which bisects the picture seen on the ground-glass screen, and is co-planar with a second vertical wire inside the camera. This wire casts a shadow, which is clearly discernible on the sensitive plate or film when developed, and thus marks the center line of the picture. Behind this wire is a compass mounted on a rack inside the camera, by means of which when a photograph is to be taken, it can be moved back until it just fails to touch the plate. The graduation of the compass card is carried out on a vertical strip of translucent material, through which the light passes to the plate, thus photographing thereon the compass bearing. A horizontal fibre is also placed inside the body of the camera, similarly to the vertical one which, when the instrument has been properly levelled, indicates the true horizon.

THE FIRST PATENT FOR ELECTRICAL GENERATing apparatus other than batteries ever granted by the United States was on an apparatus for killing whales by electricity. It was numbered 8,843 and was issued March 30, 1852, to two inventors named Sonnenburg and Rechten.

MECHANICAL FLIGHT has at last been accomplished, according to the annual report of Prof. Samuel Langley, Director of the Smithsonian Institution. On May 16, last, a mechanism built chiefly of steel, and driven by a steam engine made two flights of over half a mile. Since that time the length of flight has been nearly doubled. In each case there was no support from gas, and the machine was a thousand or more times heavier than the air it displaced. The results of the first of these experiments have been communicated by Dr. Alexander Graham Bell, who witnessed them, to the Academy of France. Prof. Langley thinks that in the accomplishmentof these results, which have been done under charge of the Smithsonian Institution, it has made a contribution to the utilities of the world which will be memorable.

A TEXTILE SCHOOL has been established in Lowell, Mass. The city appropriated $25,000 for its support, and the manufacturing concerns of the place contributed $50,000 in machinery and other facilities. The equipment is said to compare favorably with that of similar schools in England and on the Continent, where they have been maintained for a number of years, and are constantly growing in number. It is stated that the completion of Southern mills in the production of ordinary grades of cotton goods has led the Lowell manufacturers to turn their attention to the finer grades, which have hitherto generally been imported from Europe, where the textile schools have been of great aid in training skilled workmen, designers, etc.

BOOK REVIEWS.

APPLICATION GENERALE de la Nomographie au Calcul des Profils de Remblai et Deblai, avec une instruction pratique pour la construction et le mode d'emploi des abaques a points isoplethes. Par Maurice d'Ocagne Ingenieur des Ponts et Chaussees, Professeur a l'Ecole des Ponts et Chaussees, Repetiteur a l'Ecole Polytechnique. Paris, Yve. Ch. Dunod et P. Yicq, Editeurs, 49 Quai des Grands-Augustins. 8vo.; pamphlet; pp. 80; with diagrams.

Nomography is the art of writing, or of inditing laws; and in this work the author seeks to lay down a common law applying to all calculations for obtaining the areas and contents of excavations and embankments, founded upon the graphical method. He also discusses the simplest methods of thus obtaining the results sought for, and he gives practical examples which will permit the use of the method by those who do not care to enter into the somewhat complex mathematical discussion presented. The problems he seeks to solve are those expressed in the following terms: Each profile is characterized by the two variable elements of the slope upon the axis of the cut or fill and the transverse declivity of the natural ground. With these elements given, the student is to construct one or more "abaques," or graduated scales, from which may be immediately read the areas of the cut or fill, the length of the slope, etc. For this purpose he describes the construction and use of six scales, intended for finding the cuts and fills under varying conditions; but for this detail and the principles upon which the method is founded those interested must be referred to the pamphlet itself.

THE ARGENTAURUM PAPERS. NO. 1.—Some Remarks Concerning Gravitation. Addressed to the Smithsonian Institution, the Academie des Sciences, the Royal Society and all other Learned Bodies. By Stephen H. Emmens, Member of the American Institute of Mining Engineers, etc., etc. Plain Citizen Publishing Co., No. 1 Broadway, New York. 8vo.; cloth; pp. 149. $2.

This book is, among other things, a criticism of the Newtonian theory of gravitation. Its title serves as a reminder that its author claims to have discovered a process for transforming silver to gold, and is perhaps a hint that this is the thin end of the wedge by which the rationale of his process is to be demonstrated to the scientific world. In an "envoy" to the book he betrays a strong desire to have his theories discussed by the engineering and scientific journals. Our contemporary, "Science," took him at his word and published a criticism of the book in its issue of Feb. 19. Mr. Emmens' reply to this review was, according to a letter which he has sent to this journal, instruction to his attorneys to begin an action against Prof. R. S. Woodward, of Columbia University, New York, and Prof. J. McK. Cattell, chief editor of "Science." He also sent to every other member of the editorial committee in charge of "Science" a letter, which closes as follows:

I therefore ask you to inform me whether you disclaim responsibility for the Woodward-Cattell affront to Science. Should you not send me any disclaimer, I shall of course know that you approve of the malicious publication and are prepared to encounter my demand for redress in a court of law.

According to newspaper reports, Mr. Emmens places his damages at $50,000 in his suit against Prof. Woodward.

We freely confess that we have no strong desire to critically review the book of so belligerent an author. Emmensite is altogether too dangerous an explosive for us to handle in these columns, and we shall therefore repress our strong desire to set forth to our readers the faults and fallacies of Mr. Emmens' book.

ENGINEERING CHEMISTRY.—A Manual of Quantitative Chemical Analysis for the Use of Students, Chemists and Engineers. By Thomas B. Stillman, M. Sc., Ph. D., Professor of Analytical Chemistry in the Stevens Institute of Technology. Chemical Publishing Co., Easton, Pa. 8vo.; cloth; pp. 523; 154 illustrations. $4.50.

The author of this work has for many years been in charge of the department of analytical chemistry in a school of mechanical engineering, and has, therefore, had excellent opportunities to select from the vast field of chemical research those portions which are most useful to the engineer. An extensive knowledge of inorganic chemistry and some familiarity with actual chemical laboratory practice is now considered an important part of an engineer's education. The following list of subjects selected from the preface and contents will give an idea of how many points of contact there are between the fields of work of the engineer and the chemist: Blast Furnace Practice, Testing of Iron and Steel and of the Metallic Alloys, Railroad Laboratory Practice, Water Analysis and Purification, Boiler Scale, Heating Value of Fuels, Gas Analysis and Valuation, Lubrication, Gas Illumination, Cement, Clay, Brick, Building Stone, Paper, Paint.

The method of treatment adopted by the author is in the main that of the student's chemical laboratory, in which exact directions are laid down for the separation and determination of the several chemical elements. This work presupposes some knowledge of chemistry on the part of the student and even some experience in chemical manipulation. Eleven elementary exercises, such as the determination of iron in iron wire, of copper in copper sulphate, and the like are given in the beginning of the book, and it is recommended that every student perform these exercises under proper supervision, and then select a course of study, such as: iron and steel chemistry; railroad laboratory practice; the chemical technology of fuels, etc. Some of the principal subjects which are especially well treated are: coal and coke analysis; analysis of iron ores; analysis of water for scale-forming ingredients; chemical and physical examination of Portland cement; analysis of chimney gases; physical tests af building stones; alloys; examination of lubricating oils. This last subject is treated with especial care, 60 pages of the book being devoted to it. The style of the author is very clear, the typography and illustrations are good, and we take pleasure in commending the book as a whole to engineers and to the chemists who have to solve problems raised by engineers.

THE MECHANICAL ENGINEERING OF POWER PLANTS.—By Frederic Remsen Hutton, E. M., Ph. D., Professor of Mechanical Engineering in the School of Engineering of Columbia University. New York, John Wiley & Sons; London, Chapman & Hall, Ltd.; 8vo.; pp. 725; 512 illustrations. $5.

The work here presented is altogether an admirable one in its scope and method of treatment; but we regret that the author has not chosen a title which would more clearly express its real subject, such, for instance, as "The Mechanism of Steam-Power Plants." It contains nothing about water wheels, wind or tide-mills, or electric generators, so that the word power-plant as here used is too comprehensive. The term "mechanical engineering" also is generally taken as inclusive of all the theoretical principles and mathematical calculations which enter into the design of a plant, and all these the author purposely excludes from his work. In his preface he says:

This book is not intended to be a complete treatise upon the power plant, but solely upon that department which for the time being may be called "the mechanical engineering" of the power plant as distinguished from the "dynamical engineering" of the power plant, which would rightly and properly form a second and further department of the subject.

In regard to this we would say that a complete treatise on power plants would be mechanical engineering and nothing else, that "dynamical engineering" is a rarely used and entirely unnecessary term, exactly synonymous with "mechanical engineering," or that branch of engineering which deals with motive power or with forces in motion, as distinguished from what might be called "statical engineering," commonly called "civil engineering." We have not hitherto known it to be used to designate a branch of mechanical engineering. A "Treatise on Power Plants" might be divided into two parts: 1, Description of the plant and its equipment and functions; 2, theory and design of the equipment and of the plant as a whole. The first of these parts is what Prof. Hutton's book includes. The author's idea, and it seems to be an excellent one, is that the student in beginning his studies of steam engines, boilers and their accessories should follow the natural method of exercising his observing powers on actual examples of apparatus, and become familiar with the power house from its practical side and "with the solutions which experience and good judgment have proposed for problems of this sort." He would leave the theoretical study of steam engineering to follow the study of its practice. In furtherance of this idea the author in this volume has avoided both theory and mathematics, and has discussed the power plant from the standpoint of an accurate observer and questioner about details and their uses. The work is copiously illustrated with numerous examples of different types of engines, boilers, feed water heaters, condensers, etc., and together with descriptions gives statements of the advantages and disadvantages of different types. Some of the disadvantages stated may be considered too strong by the makers of the several types, but on the whole they will be recognized by engineers as eminently fair and judicious. An appendix gives numerous references to other works in which questions of design are treated. We heartily commend the work as the best we have seen covering its particular field, and one that will be found useful by engineers of power plants as well as by students.